SHIP MOTION TRIALS OF USCGC TAMAROA AND USCGC CHEROKEE

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Avery Point Groton, Connecticut 06340

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16. Abstract

This report documents the results of ship motion trials performed on the 205-foot WMEC's USCGC TAMAROA and USCGC CHEROKEE. The trials were conducted in April 1981. Roll motions are presented together with pitch motions in head seas. The trials were run using six orientations to the principal wave direction and three different ship speeds. The results of the trials between the two ships are compared.

There appears to be no measurable difference in the roll response characteristics of the two vessels, one of which was ballasted and one unballasted. Test personnel who rode both vessels could detect no ride difference as well.

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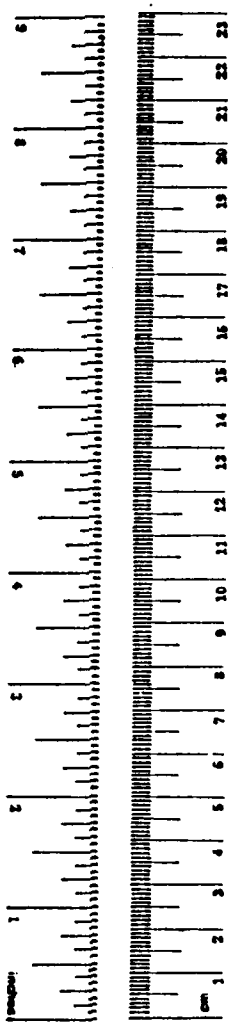
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

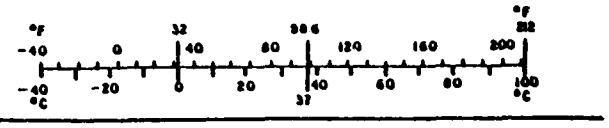
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1.0 INTRODUCTION

Seakeeping and dynamic stability tests were conducted on two 205' cutters, USCGC CHEROKEE and USCGC TAMAROA during April of 1981. These tests are a portion of the Coast Guard's advanced marine vehicle and ship trials program, one objective of which focuses on documenting and analyzing ship motion data for the various classes of Coast Guard vessels. The 205's were the first class to be tested under this program. This report presents the results of those tests.

Two vessels were instrumented and tested in this class in order to draw a comparison between the recently ballasted TAMAROA and the unballasted CHEROKEE. The objectives of the test program were:

a. To determine the response amplitude operators of the vessel to waves in as many as six degrees of freedom (i.e., roll, pitch, yaw, heave, sway and surge).

b. To determine the significant H 1/3 wave height and the corresponding average of the 1/3 highest vessel motions.

2.0 TESTING AND INSTRUMENTATION

2.1 General

The motion data was collected at three different vessel speeds (1-2 kts, 5 kts, 10 kts) and six headings relative to the prevailing seas (90^{o}, 270^{o} beam seas) (0^{o} and 180^{o} head and following seas) (45^{o} and 225^{o} bow quartering and following quartering seas). Two different sea states (a low H 1/3 of approximately 4 feet and a high H 1/3 of 10-15 feet) were desired. For each ship test, two series of data were recorded; however, the wave heights ranged from 4-8 feet during both. Each course was run for 20 minutes while recording the data. The data collected for each run consisted of:

a. wave height versus time
b. vessel motion versus time (roll; pitch; yaw; heave, surge, and sway acelerations)
c. water depth
d. operating configuration
e. shaft rpm
f. apparent wave direction
g. vessel course
h. draft and trim of vessel
i. wind speed and direction

Appendix A lists the wave direction, wind direction, ship headings and operating configuration information for the vessels for each test run. Time and loading information is also given in Appendix A.

2.2 Instrumentation

The instrumentation used for measuring the motion data consisted of a gyro stabilized platform having a reference to the horizontal and to a fixed horizontal angle. A 14-channel analog tape recorder was used to record the data. Ship angular motions (roll, pitch, yaw) were measured relative to the fixed reference. The linear motions (heave, sway, surge accelerations) were measured in g's using the same fixed reference. For both vessels, the motion package was placed as close to the vertical and horizontal center of gravity as physically possible. For the CHEROKEE, this was on the deck just forward of the main switchboard in B-2 engine room. On the TAMAROA, the package was placed on the deck aft of the main switchboard. For both vessels, the package was hard wired to the recording equipment located in the machine shop. Figure 2 shows the locations of the motion package during both tests.

Wave data (height) was measured and transmitted to the test vessel by a Datawell waverider bucy. Each run began or ended in the vicinity of the buoy in order to increase the validity of the correlation between wave measurements and ship motions. Also, since the buoy was free floating, this minimized the chances of losing the buoy.

Data on the motions and wave height was recorded in FM analog form by a 14-channel magnetic tape recorder. A strip chart recorder was also used for the wave height information. This provided a ready visual means of determining proper buoy transmission.

3.0 ANALYSIS OF DATA

Wave data and ship motion data for roll were analyzed for each run. Pitch data was also analyzed for the runs made with head seas. None of the other data collected was studied. A total of 72 test runs were made.

The data was converted from the time versus amplitude representation on the analog tape to an amplitude versus frequency form using a Hewlett-Packard 5420A digital signal analyzer. A Hanning windowing function was used. The data were recorded at 1-7/8 inches/second and analyzed at 30 inches/second. The data were then converted by a Hewlett-Packard 9835B computer to the proper frequency and amplitude and plotted. The analysis was performed using a bandwidth of 32 Hz which corresponds to 2 Hz real time. Coupling between the tape recorder and analyzer was D.C. to avoid loss of data due to the A.C. coupling capacitor's roll-off in the frequency range being analyzed.

Calibration factors were entered into the digital signal analyzer to convert the voltage signal on the analog tape into the correct engineering units. Because the analyzer gives results as RMS voltage, a correction was used to obtain peak voltage results. The calibration factors were computed as follows:

$$\text{Factor} = C_1 \times C_2 \times C_3 \times \sqrt{2}$$

where

C_1 = Motion package (wave buoy) engineering units/V
e.g., 9^o/V for roll
C_2 = Tape recorder attenuation, e.g., 5 volts in/1 volt out
C_3 = Units conversion, e.g., meters to feet
$\sqrt{2}$ = Converts RMS voltage to peak voltage

Data for roll, pitch, and wave height has been plotted in the form of energy spectral density; that is, the area under the curve between two frequencies is proportional to the roll, pitch, or wave energy between those frequencies. The wave spectrum has been corrected to frequency of encounter using the ship speed and direction.

Response amplitude operators (RAO's) were computed by dividing the respective roll or pitch energy spectrums by the corresponding wave energy spectrum. The RAO's should be used with caution because they were not obtained in a theoretically correct manner. The primary problem is that the waves were not unidirectional. However, the data was collected at corresponding ship speeds and direction to the waves on the USCGC CHEROKEE and the USCGC TAMAROA.

The averages of the 1/3 and 1/10 highest waves and vessel roll motions are included in Tables 1 and 2. These were obtained from measuring the actual wave and motion heights. These values can also be estimated from the value of energy given on the plots using the following formula:

$$H_{1/3} = 2.83\ (\text{Energy})^{1/2}$$

$$H_{1/10} = 3.60\ (\text{Energy})^{1/2}$$

A Rayleigh distribution is assumed. Figure 1 shows a comparison between the actual wave height data for one run of the USCGC TAMAROA and the Rayleigh distribution corresponding to the energy for this run. The values of $H_{1/3}$ are noted on this figure.

4.0 RESULTS

Data plots are given in Appendix B. The test results vary widely. This is even true between runs made on different days on the same ship. The cause of the wide variation is not known for certain. However, some of the contributing factors are that the waves were not unidirectional and that the wave buoy was not located at the bow of the vessel. In head or stern seas there should theoretically be no roll motion if the waves are unidirectional and there are no motion coupling effects. The fact that the figures show a substantial RAO value for head and stern seas shows the influence of non-unidirectional waves. Also, the waves at the buoy location may be somewhat different from those at the vessel. In other words, the spatial distribution of energy in the area may not be uniform.

Because of the wide variation in data on the individual vessels, it is difficult to see any significant differences between the TAMAROA and the CHEROKEE. Both ships had similar RAO amplitude ranges and the frequency of roll on both ships was very close. The CHEROKEE had possibly the lower roll frequency (0.105 Hz versus 0.112 Hz for the TAMAROA).

In general, there is no roll motion difference between the two ships apparent as a result of these tests. Pitching motion RAO's on the CHEROKEE were slightly higher than those of the TAMAROA.

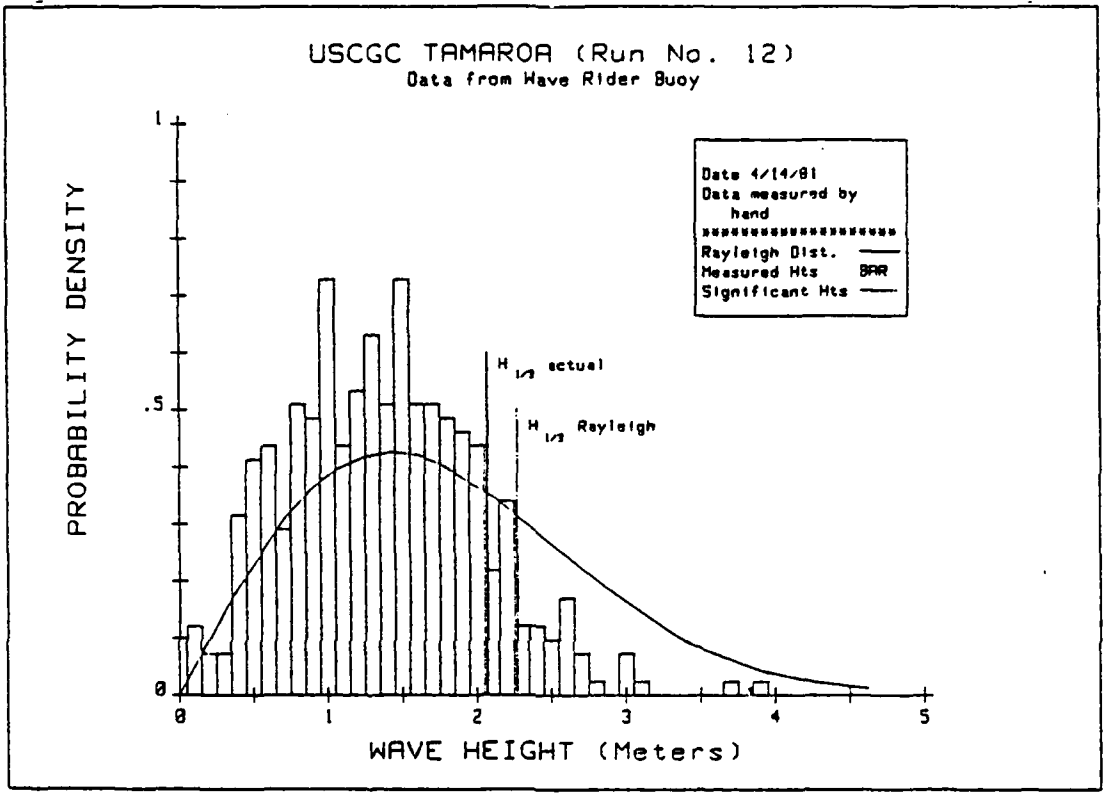
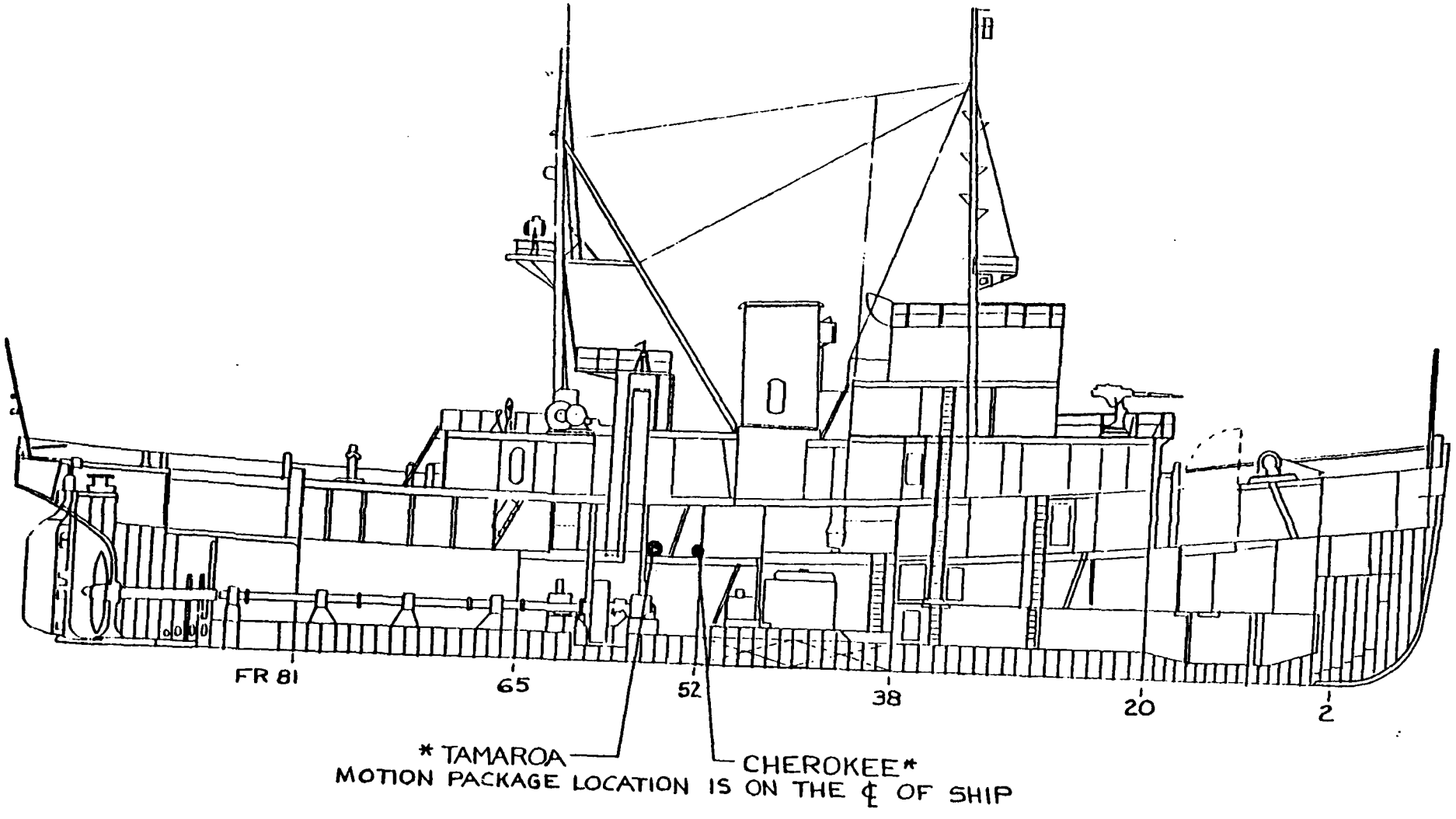

USCGC TAMAROA (Run No. 12)
Data from Wave Rider Buoy
PROBABILITY DENSITY
1
.5
0
0
1
2
3
4
5
WAVE HEIGHT (Meters)
Date 4/14/81
Data measured by
hand
Rayleigh Dist.
Measured Hts BAR
Significant Hts
H 1/3 actual
H 1/3 Rayleigh

FIGURE 1



205' WMEC

FIGURE 2

TABLE 1

TABLE OF SIGNIFICANT WAVE AND ROLL HEIGHTS

USCGC TAMAROA

DATE OF RUN	RUN NUMBER	HEADING TO WAVES	WAVE HEIGHT (METERS)		ROLL ANGLE (DEGREES)	
			$H_{1/3}$	$H_{1/10}$	$H_{1/3}$	$H_{1/10}$
04/14/81	1	Head	2.407	2.910	9.097	11.622
	2	Stern	2.393	3.038	20.636	24.873
	3	Fwd Qtr (P)	2.465	3.107	13.225	17.452
	4	Aft Qtr (S)	2.302	2.904	19.022	23.059
	5	Port Beam	2.526	3.214	17.640	23.441
	6	Stbd Beam	2.392	2.939	18.746	23.318
	7	Head	2.251	2.811	8.495	10.294
	8	Stern	2.347	2.957	21.280	25.585
	9	Fwd Qtr (P)	2.244	2.762	12.042	14.995
	10	Aft Qtr (S)	2.206	2.645	20.882	26.209
	11	Port Beam	2.240	2.858	18.063	21.844
	12	Stbd Beam	2.150	2.692	18.025	21.419
	13	Head	2.179	2.787	13.459	15.976
	14	Stern	2.185	2.657	17.992	22.577
	15	Fwd Qtr (P)	2.302	2.894	13.316	17.177
	16	Aft Qtr (S)	2.150	2.770	17.797	21.282
	17	Port Beam	2.182	2.721	13.897	17.753
	18	Stbd Beam	2.273	2.795	20.637	23.818
04/15/81	1	Port Beam	1.470	1.792	4.891	5.720
	2	Stbd Beam	1.604	2.115	15.277	17.846
	3	Stern	1.410	1.730	9.938	11.399
	4	Head	1.467	1.809	5.206	6.243
	5	Fwd Qtr (P)	1.269	1.522	3.845	4.816
	6	Aft Qtr (S)	1.407	1.833	12.032	15.034
	7	Port Beam	1.342	1.626	4.169	5.136
	8	Stbd Beam	1.173	1.448	8.935	10.278
	9	Fwd Qtr (P)	1.168	1.402	4.905	5.685
	10	Aft Qtr (S)	1.157	1.406	10.690	12.644
	11	Stern	1.046	1.297	11.763	13.441
	12	Head	1.047	1.305	6.852	7.744
	13	Head	1.013	1.232	7.642	9.731
	14	Stern	0.950	1.170	8.362	9.161
	15	Stbd Beam	0.862	1.040	6.585	7.510
	16	Port Beam	0.942	1.146	4.644	5.440
	17	Fwd Qtr (P)	0.887	1.094	8.029	9.580
	18	Aft Qtr (S)	0.800	0.950	8.668	10.788

TABLE 2

TABLE OF SIGNIFICANT WAVE AND ROLL HEIGHTS

USCGC CHEROKEE

DATE OF RUN	RUN NUMBER	HEADING TO WAVES	WAVE HEIGHT (METERS)		ROLL ANGLE (DEGREES)	
			$H_{1/3}$	$H_{1/10}$	$H_{1/3}$	$H_{1/10}$
04/04/81	1	Head	1.454	1.763	5.096	6.186
	2	Stern	1.432	1.796	8.412	10.427
	3	Port Beam	1.429	1.750	5.748	7.112
	4	Stbd Beam	1.433	1.758	5.540	6.877
	5	Fwd Qtr (S)	1.346	1.625	5.369	6.088
	6	Aft Qtr (P)	1.427	1.776	6.369	7.829
	7	Fwd Qtr (S)	1.575	1.976	4.181	4.763
	8	Aft Qtr (P)	1.548	1.886	11.313	13.746
	9	Port Beam	1.639	2.082	11.127	14.419
	10	Stbd Beam	1.522	1.880	4.562	5.722
	11	Head	1.680	1.975	5.003	5.746
	12	Stern	1.597	1.970	12.990	15.166
	13	Head	1.567	1.907	3.627	4.378
	14	Stern	1.593	1.992	14.517	17.723
	15	Fwd Qtr (S)	1.594	1.969	3.812	4.551
	16	Aft Qtr (P)	1.555	1.859	10.333	13.308
	17	Port Beam	1.629	2.077	12.242	15.158
	18	Stbd Beam	1.733	2.198	7.683	9.187
04/06/81	1	Head	1.512	1.912	9.921	11.646
	2	Stern	1.531	1.921	10.952	15.023
	3	Stbd Beam	1.678	2.092	16.820	19.759
	4	Port Beam	1.409	1.775	20.126	24.221
	5	Aft Qtr (P)	1.340	1.649	20.509	24.524
	6	Fwd Qtr (S)	1.591	2.032	20.101	24.708
	7	Stern	1.356	1.866	10.359	12.900
	8	Head	1.613	2.039	8.218	11.201
	9	Aft Qtr (P)	1.600	1.963	17.712	21.391
	10	Fwd Qtr (S)	1.744	2.256	18.049	23.325
	11	Stbd Beam	1.759	2.149	19.834	24.115
	12	Port Beam	1.801	2.269	20.545	24.644
	13	Aft Qtr (P)	1.777	2.222	13.695	18.057
	14	Fwd Qtr (S)	1.046	2.517	8.899	10.991
	15	Stbd Beam	1.212	2.816	15.071	18.751
	16	Port Beam	1.045	2.690	15.463	19.056
	17	Head	1.100	2.720	5.848	7.042
	18	Stern	1.173	2.685	12.817	15.635

APPENDIX A

DATA FORMS

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME CHEROKEE DATE 4/4/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A.

RPM 30 SPEED 2 KTS

DRAFT FORWARD 14' - 4" DRAFT AFT 14' 8"

APPARENT WAVE DIRECTION 220 TRUE

WIND SPEED 11 KTS WIND DIRECTION 180° TRUE

WATER DEPTH 450 FATHOMS

LOCATION OF MOTION PACKAGE FWD B-7

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
1	220	HEAD	0847	0908
2	040	STERN	0916	0936
3	310	BEAM (PORT)	0940	1000
4	130	BEAM (STBD)	1010	1031
5	175	BOW QTR (STBD)	1036	1056
6	355	STERN QTR (PORT)	1107	1128

DATA DISK/TAPE NUMBER CHEROKEE #1

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME CHEROKEE DATE 4/4/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A.

RPM 55 SPEED 5.5

DRAFT FORWARD 14'-4" DRAFT AFT 14'-8"

APPARENT WAVE DIRECTION 220 TRUE

WIND SPEED 15 WIND DIRECTION 210 TRUE

WATER DEPTH 450 FATHOMS

LOCATION OF MOTION PACKAGE FWD B-2

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
7	175	BOW QTR (STBD)	1139	1200
8	355	STERN QTR (PORT)	1206	1226
9	310	BEAM (PORT)	1228	1248
10	130	BEAM (STBD)	1255	1316
11	220	HEAD	1320	1340
12	040	STERN	1351	1411

DATA DISK/TAPE NUMBER CHEROKEE #1 & #2

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME CHEROKEE DATE 4/4/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A.

RPM 80 SPEED 10

DRAFT FORWARD 14'-4" DRAFT AFT 14'-8"

APPARENT WAVE DIRECTION 200 TRUE

WIND SPEED 16 WIND DIRECTION 160 TRUE

WATER DEPTH 450 FATHOMS

LOCATION OF MOTION PACKAGE FWD B-2

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
13	200	HEAD	1425	1445
14	020	STERN	1450	1510
15	155	BOW QTR (STBD)	1512	1532
16	335	STERN QTR (PORT)	1537	1557
17	290	BEAM (PORT)	1558	1618
18	110	BEAM (STBD)	1624	1644

DATA DISK/TAPE NUMBER CHEROKEE #2

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME CHEROKEE DATE 4/6/81

RECORDER LCDR Cook

OPERATING CONFIGURATION N A

RPM 20 SPEED 2 KTS

DRAFT FORWARD 14' 4" DRAFT AFT 14'8"

APPARENT WAVE DIRECTION 180° TRUE

WIND SPEED 11 WIND DIRECTION 280 TRUE

WATER DEPTH 125 FEET

LOCATION OF MOTION PACKAGE FWD B-2

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
1	180°	HEAD	0859	0919
2	000°	STERN	0926	0946
3	090°	BEAM (STBD)	0950	1010
4	270°	BEAM (PORT)	1018	1038
5	045°	STERN QTR (STBD)	1046	1106
6	225°	BOW QTR (PORT)	1115	1135

DATA DISK/TAPE NUMBER CHEROKEE #2 & #3

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME CHEROKEE DATE 4/6/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A.

RPM 50 / 1 ENGINE SPEED 5 KTS

DRAFT FORWARD 14' 4" DRAFT AFT 14' 8"

APPARENT WAVE DIRECTION 180° TRUE

WIND SPEED 12 KTS WIND DIRECTION 300 TRUE

WATER DEPTH 125 FEET

LOCATION OF MOTION PACKAGE FWD B-2

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
7	000	STERN	1143	1203
8	180	HEAD	1210	1230
9	045	STERN QTR (STBD)	1234	1254
10	225	BOW QTR (PORT)	1258	1318
11	090	BEAM (STBD)	1331	1351
12	270	BEAM (PORT)	1357	1417

DATA DISK/TAPE NUMBER CHEROKEE #3

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME CHEROKEE DATE 4/6/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A.

RPM 80 / 2 ENGINES SPEED 10

DRAFT FORWARD 14' 4" DRAFT AFT 14' 8"

APPARENT WAVE DIRECTION 180 TRUE

WIND SPEED 12 KTS WIND DIRECTION 300° TRUE

WATER DEPTH 125 FEET

LOCATION OF MOTION PACKAGE FWD B-2

	RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
	13	045	STERN QTR (STBD)	1421	1441
*	14	225	BOW QTR (STBD)	1505	1524
**	15	090	BEAM (STBD)	1552	1611
	16	270	BEAM (PORT)	1615	1635
	17	180	HEAD	1636	1656
	18	000	STERN	1700	1720

DATA DISK/TAPE NUMBER CHEROKEE #3 & #4

* PRIMARY SEA STATE CHANGED TO SEAS FROM 270°, TRUE WIND 270° @ 14 KTS

** PRIMARY SEAS BACK TO 180

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME TAMAROA DATE 4/14/81

RECORDER LCDR Cook

OPERATING CONFIGURATION N.A.

RPM 38 SPEED 3 KTS

DRAFT FORWARD 13' DRAFT AFT 14'

APPARENT WAVE DIRECTION 110° TRUE

WIND SPEED 21 KTS WIND DIRECTION 110° TRUE

WATER DEPTH 1600 FATHOMS

LOCATION OF MOTION PACKAGE AFT B-1

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
1	110	HEAD	0845	0905
2	290	STERN	0914	0934
3	155	BOW QTR (PORT)	0940	1000
4	335	STERN QTR (STBD)	1006	1026
5	200	BEAM (PORT)	1029	1049
6	020	BEAM (STBD)	1055	1115

DATA DISK/TAPE NUMBER TAMAROA #1

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME TAMAROA DATE 4/14/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A.

RPM 55 SPEED 5

DRAFT FORWARD 13' DRAFT AFT 14'

APPARENT WAVE DIRECTION 110 TRUE

WIND SPEED 21 KTS WIND DIRECTION 110 TRUE

WATER DEPTH 1600 FATHOMS

LOCATION OF MOTION PACKAGE AFT B-1

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
7	110	HEAD		
8	290	STERN		
9	155	BOW QTR (PORT)		
10	335	STERN QTR (STBD)		
11	220	BEAM (PORT)		
12	040	BEAM (STBD)		

DATA DISK/TAPE NUMBER TAMAROA #1 & #2

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME TAMAROA DATE 4/14/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A

RPM 85 SPEED 10

DRAFT FORWARD 13' DRAFT AFT 14'

APPARENT WAVE DIRECTION ~~HO~~ 135 TRUE

WIND SPEED 21 WIND DIRECTION 110 TRUE

WATER DEPTH 1600 FATHOMS

LOCATION OF MOTION PACKAGE AFT B-1

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
13	135	HEAD	1457	1517
14	315	STERN	1524	1544
15	180	BOW QTR (PORT)	1550	1610
16	000	STERN QTR (STBD)	1613	1633
17	225	BEAM (PORT)	1643	1659
18	045	BEAM (STBD)	1700	1720

DATA DISK/TAPE NUMBER TAMAROA #2

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME TAMAROA DATE 4/15/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A

RPM 80 SPEED 10

DRAFT FORWARD 13' DRAFT AFT 14'

APPARENT WAVE DIRECTION 000 TRUE

WIND SPEED 22 KTS WIND DIRECTION 000° TRUE

WATER DEPTH 14 FATHOMS

LOCATION OF MOTION PACKAGE AFT B-1

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
1	090	BEAM (PORT)	1516	1536
2	270	BEAM (STBD)	1541	1601
3	180	STERN	1603	1623
4	000	HEAD	1627	1647
5	045	BOW QTR (PORT)	1648	1708
6	225	STERN QTR (STBD)	1713	1733

DATA DISK/TAPE NUMBER TAMAROA TAPE #3

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME TAMAROA DATE 4/15/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A.

RPM 45 SPEED 5 KTS

DRAFT FORWARD 13' DRAFT AFT 14'

APPARENT WAVE DIRECTION 000 TRUE

WIND SPEED 18 WIND DIRECTION 000 TRUE

WATER DEPTH 15 FATHOMS

LOCATION OF MOTION PACKAGE AFT B-1

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
7	090	BEAM (PORT)	1736	1756
8	270	BEAM (STBD)	1802	1822
9	045	BOW QTR (PORT)	1830	1850
10	225	STERN QTR (STBD)	1856	1916
11	180	STERN	1918	1938
12	000	HEAD	1946	2006

DATA DISK/TAPE NUMBER TAMAROA #3 & #4

DATA FORM 13A

MOTION IN WAVES

VESSEL NAME TAMAROA DATE 4/15/81

RECORDER LCDR COOK

OPERATING CONFIGURATION N.A.

RPM 35 SPEED 2 KTS

DRAFT FORWARD 13' DRAFT AFT 14'

APPARENT WAVE DIRECTION 000 TRUE

WIND SPEED 9 KTS WIND DIRECTION 350 TRUE

WATER DEPTH 15 FATHOMS

LOCATION OF MOTION PACKAGE AFT B-1

RUN NUMBER	VESSEL COURSE	DIRECTION TO WAVES	START TIME	FINISH TIME
13	000	HEAD	2010	2030
14	180	STERN	2039	2059
15	270	BEAM (STBD)	2103	2123
16	090	BEAM (PORT)	2128	2148
17	045	BOW QTR (PORT)	2150	2210
18	225	STERN QTR (STBD)	2218	2238

DATA DISK/TAPE NUMBER TAMAROA #4

LIQUID LOADING DATA

Vessel CHEROKEE Date 4/3/81

Draft Fwd 14' 4" Aft 14' 8"

TANK	GALS	TANK	GALS
A-1-W	10686 F.W	C-402-W	6108 F.W
A-404-W	4532 FW	A-405-W	4532 F.W
A-410F	3596	A-409-F	3279
B-202-F	612	B-201-F	920
B-902-F	FULL FW	B-901-F	FULL FW
B-904-F	FULL FW	B-903-F	FULL FW
B-905-F	FULL FW?	B-905-F	FULL FW
B-908-F	FULL FW	B-907-F	FULL FW
C-2-F	5991	C-1-F	6352
C-302-F	3219 L.O.	C-301-F	2336 L.O.
C-4-F	~~549~~ 2636	C-3-F	3001
C-304-F	5161	C-303-F	X
C-6-F	5421	C-5-F	5917
C-8-F	5001	C-7-F	4573

LIQUID LOADING DATA

Vessel TAMAROA Date 4/13/81

Draft Fwd 13' Aft 14'

TANK	GALS	TANK	GALS
A-1-W	10686 FW	C-402-W	7407 F/W
A-404-W	4532 FW	A-405-W	4532 FW
A-410F	2420	A-409-F	2800
B-202-F	900	B-201-F	900
B-902-F	FULL FW	B-901-F	FULL FW
B-904-F	FULL FW	B-903-F	FULL FW
B-906-F	FULL FW	B-905-F	FULL FW
B-908-F	FULL FW	B-907-F	FULL FW
C-2-F	3797	C-1-F	5352
C-302-F	1960 L.O.	C-301-F	DIRTY OIL
C-4-F	1134	C-3-F	24
C-304-F	197	C-303-F	Sewage
C-6-F	452	C-5-F	1250
C-8-F	5001	C-7-F	4802

LIQUID LOADING DATA

Vessel TAMAROA Date 4/16/81

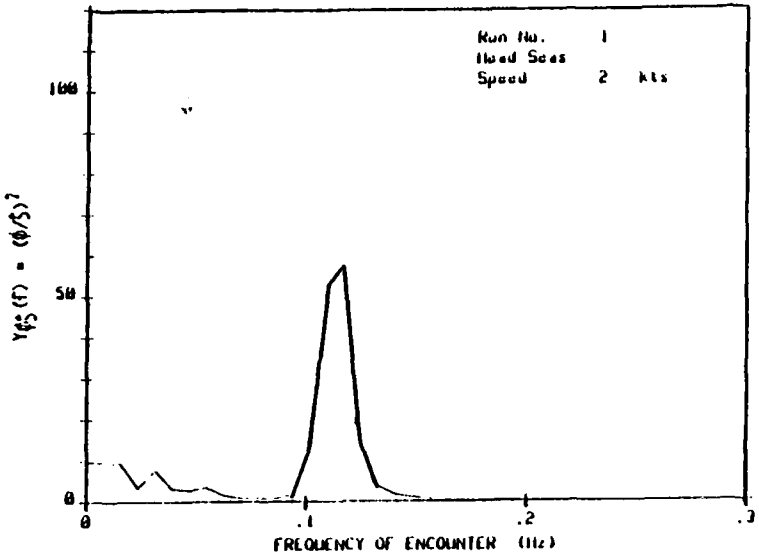
Draft Fwd 13' Aft 14'

TANK	GALS	TANK	GALS
A-1-W	6405 FW	C-402-W	6361 FW
A-404-W	4532 FW	A-405-W	4532 FW
A-410F	1136	A-409-F	958
B-202-F	900	B-201-F	900
B-902-F	3343 FW	B-901-F	3543 FW
B-904-F	4046 FW	B-903-F	4046 FW
B-906-F	2722 FW	B-905-F	2722 FW
B-908-F	3228 FW	B-907-F	3228 FW
C-2-F	3797	C-1-F	5352
C-302-F	1960 LO.	C-301-F	1085 Dirty Oil
C-4-F	1134	C-3-F	24
C-304-F	197	C-303-F	Sewage
C-6-F	452	C-5-F	1250
C-8-F	5001	C-7-F	4802

APPENDIX B

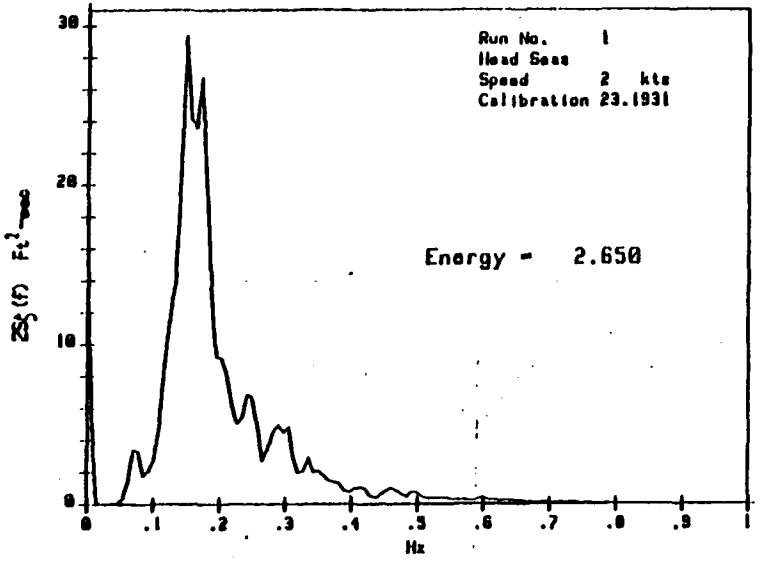
SPECTRUMS

USCGC CHEROKEE
Tested 4/4/81



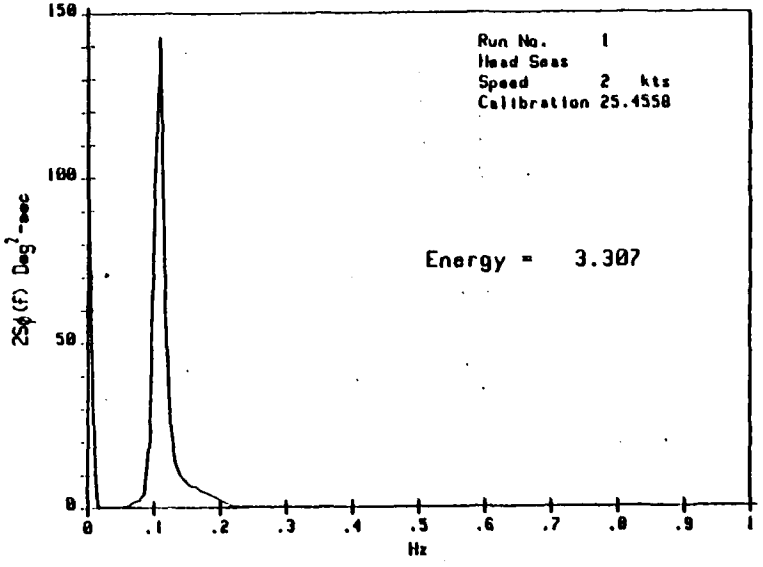
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81

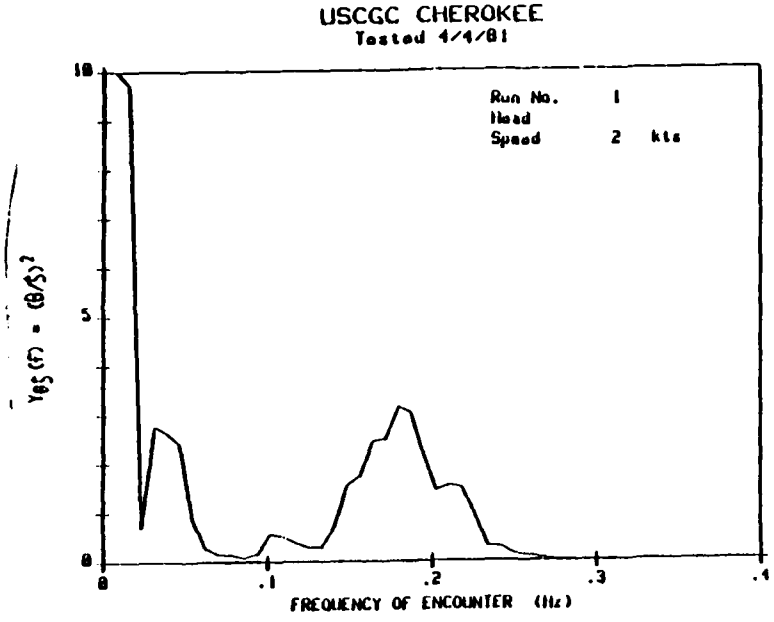


WAVE ENERGY SPECTRUM

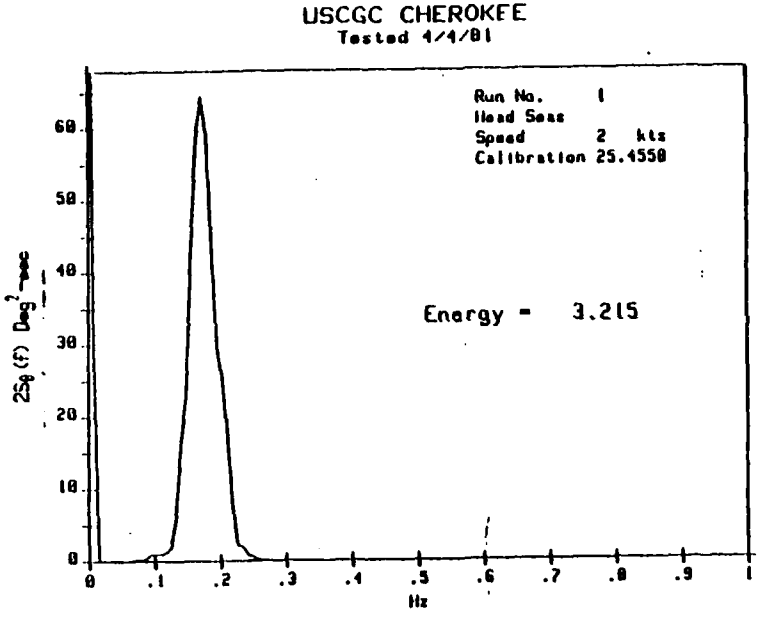
USCGC CHEROKEE
Tested 4/4/81



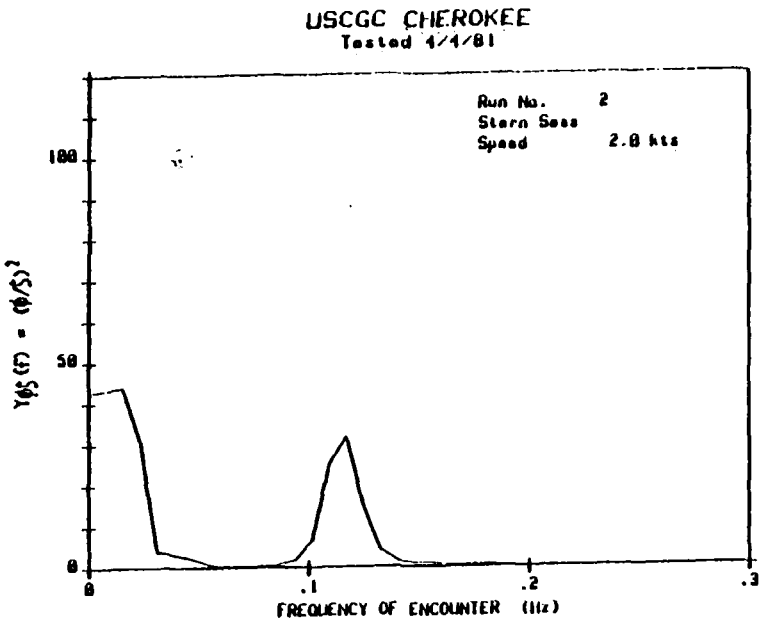
ROLL ENERGY SPECTRUM



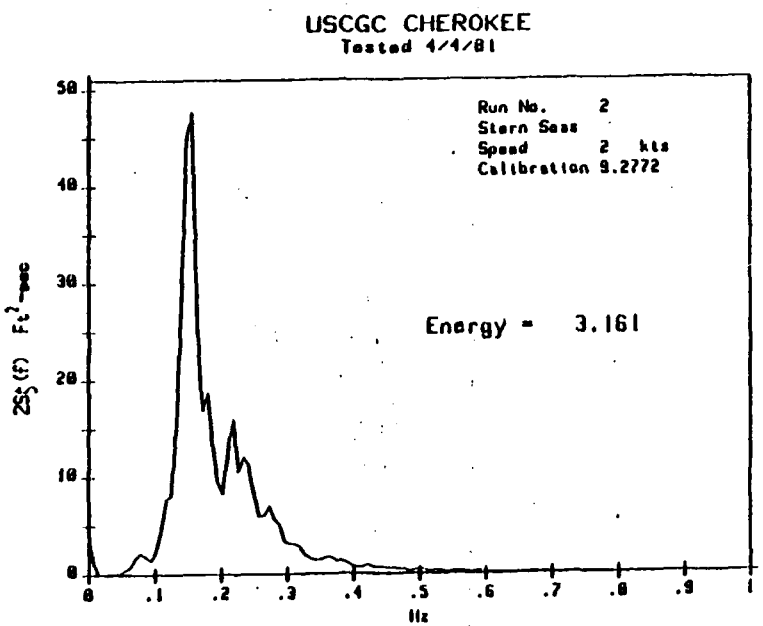
PITCH RESPONSE AMPLITUDE OPERATOR



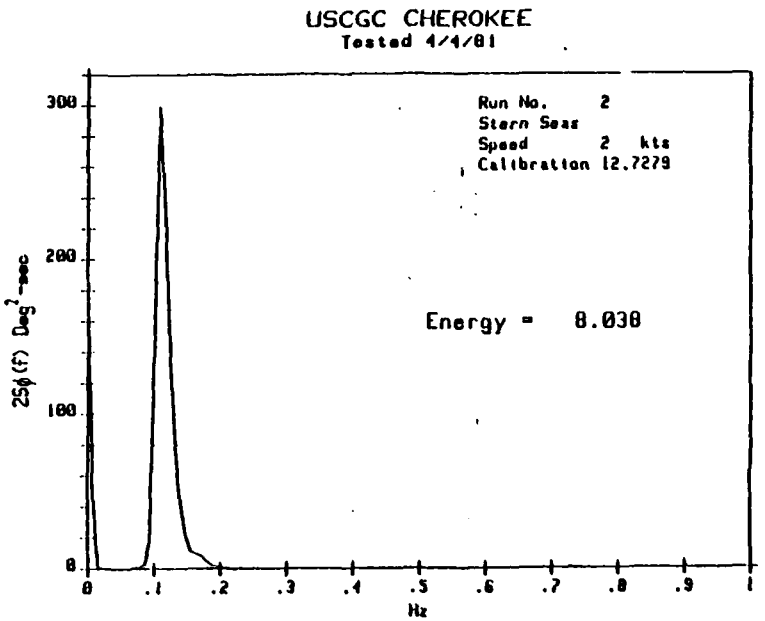
PITCH ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR

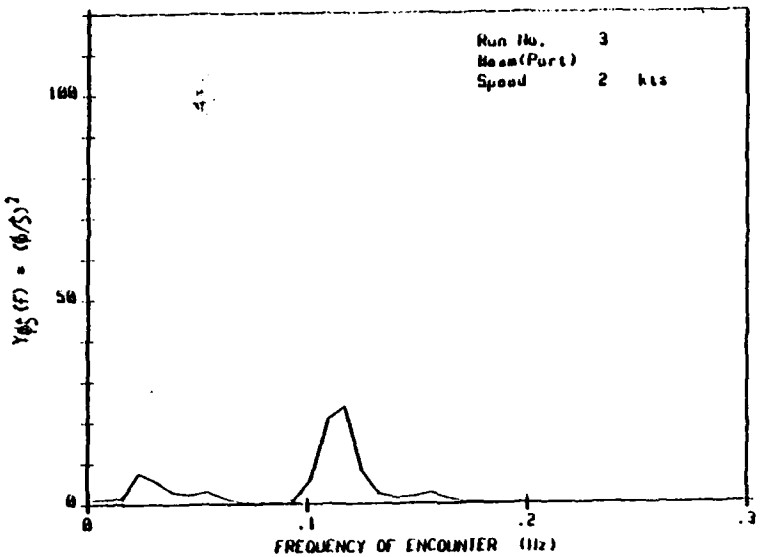


WAVE ENERGY SPECTRUM



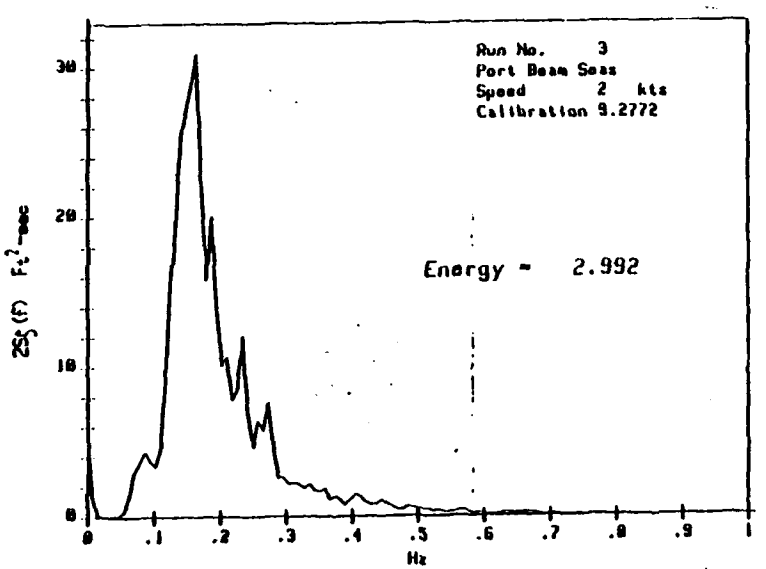
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



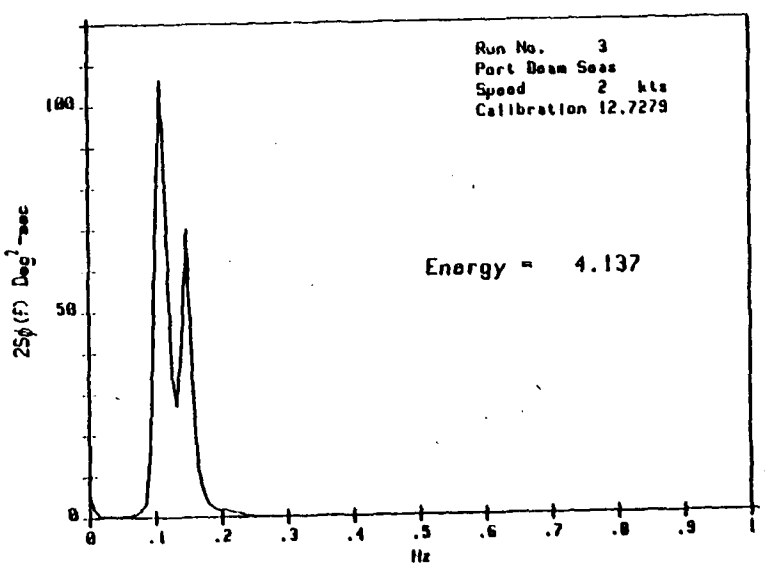
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81



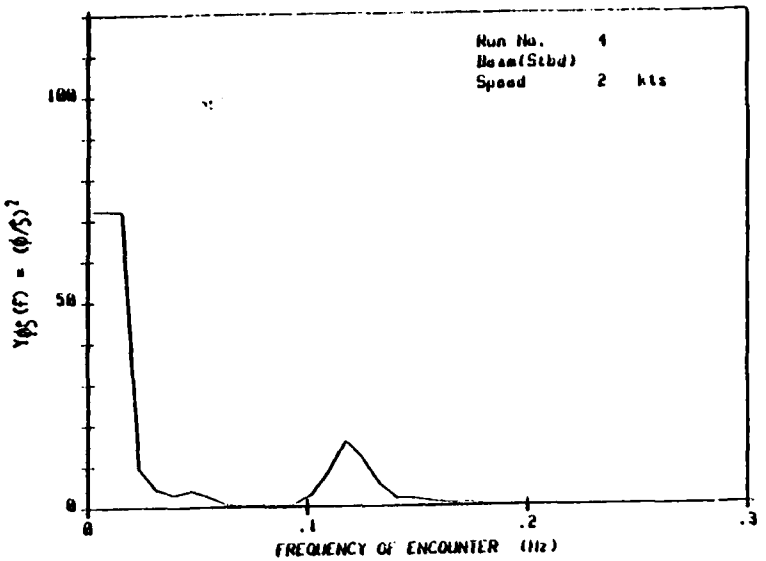
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



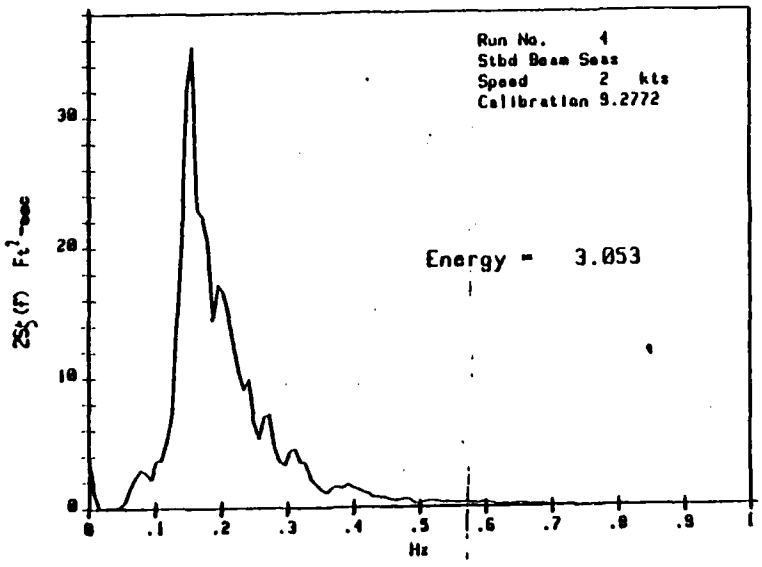
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



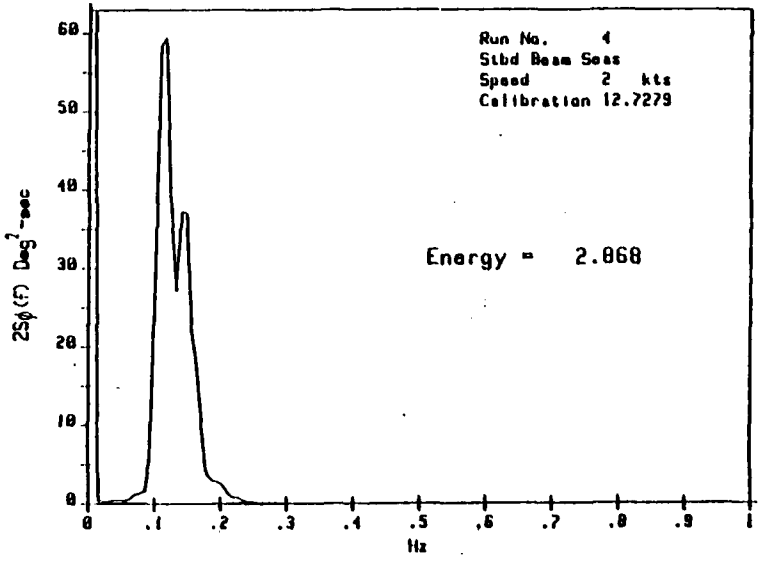
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81



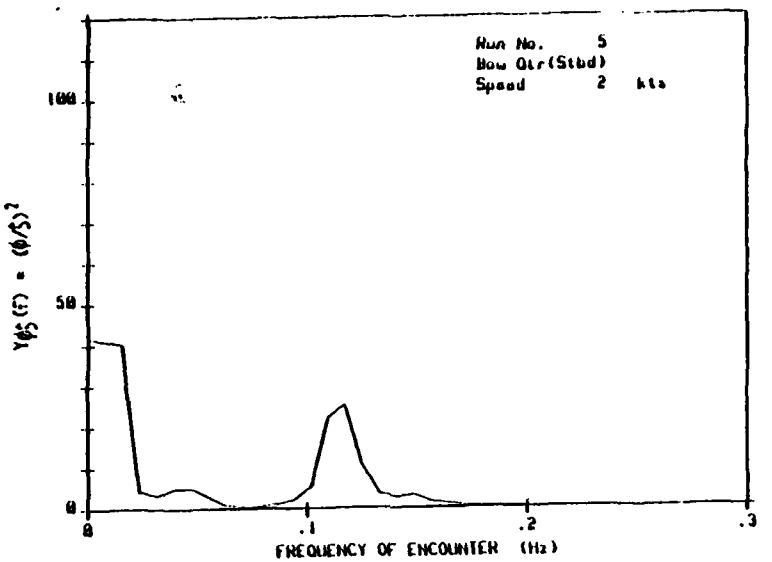
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



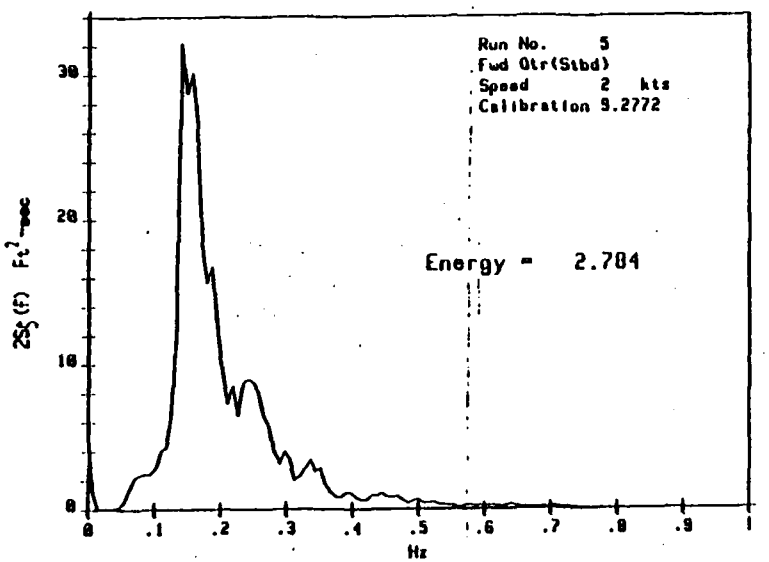
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Testud 4/4/81



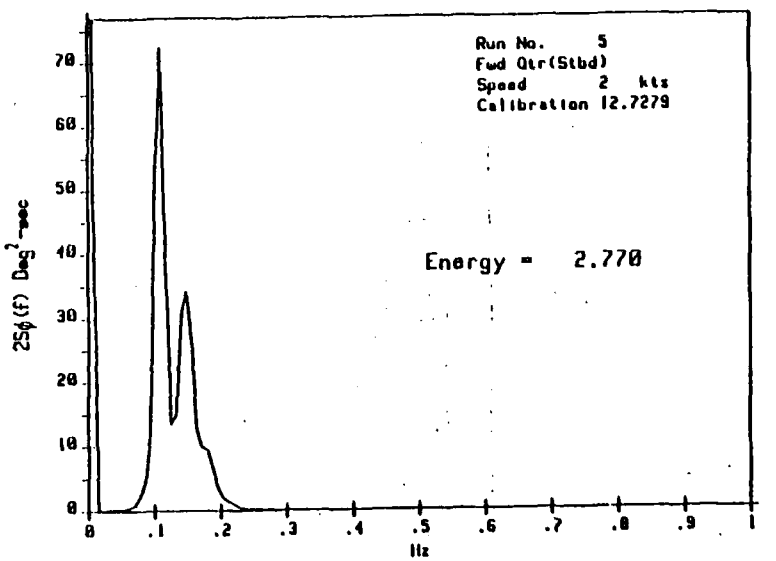
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81



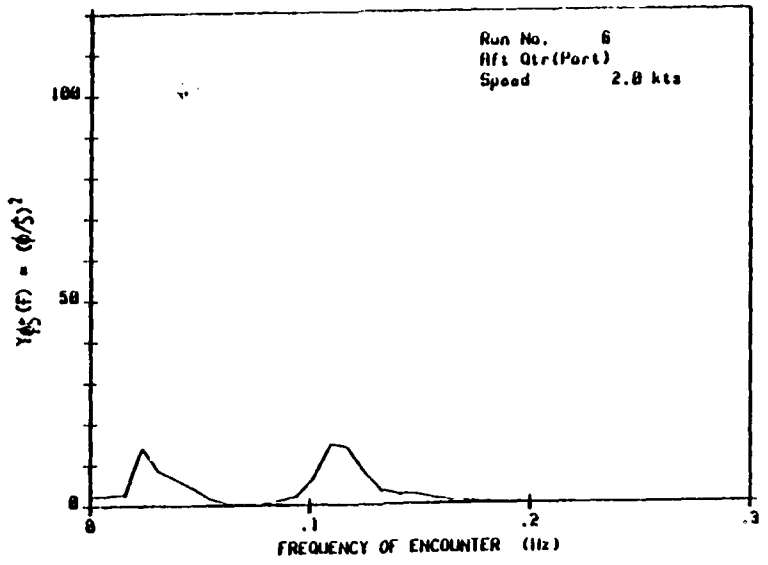
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



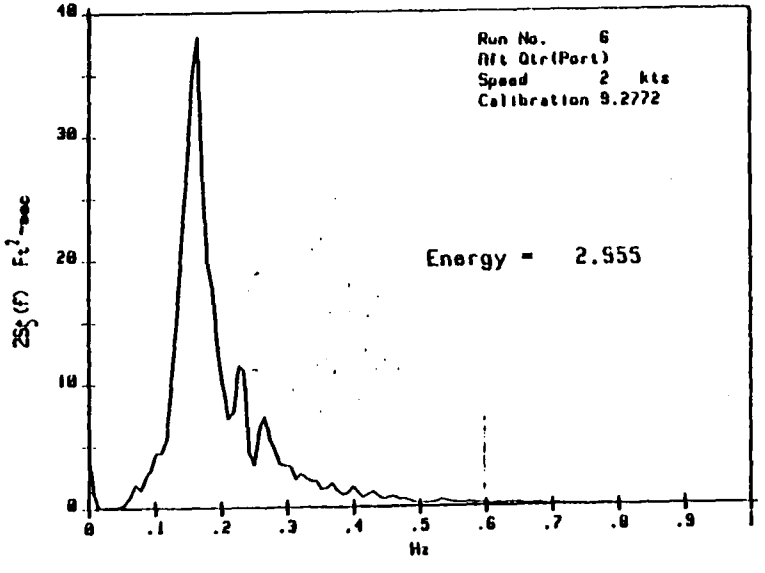
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



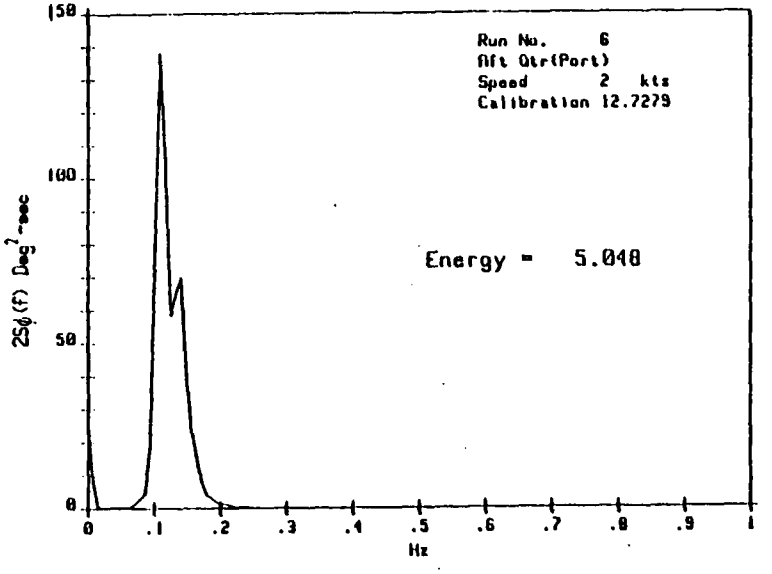
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81



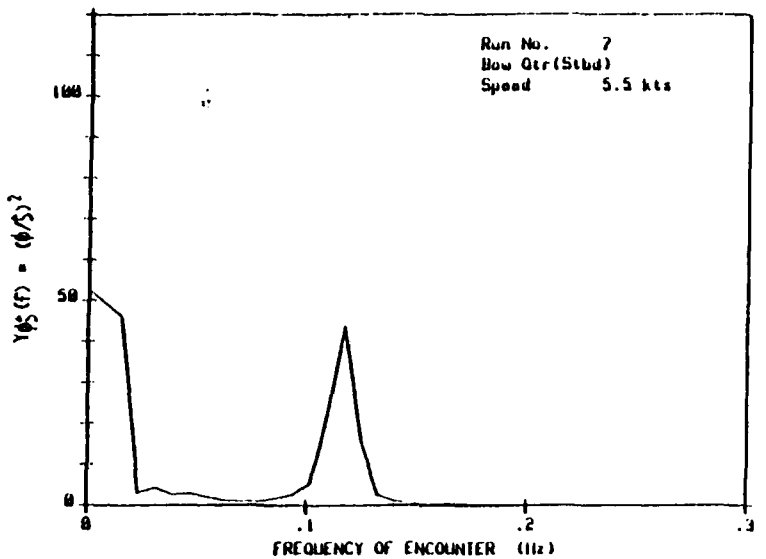
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



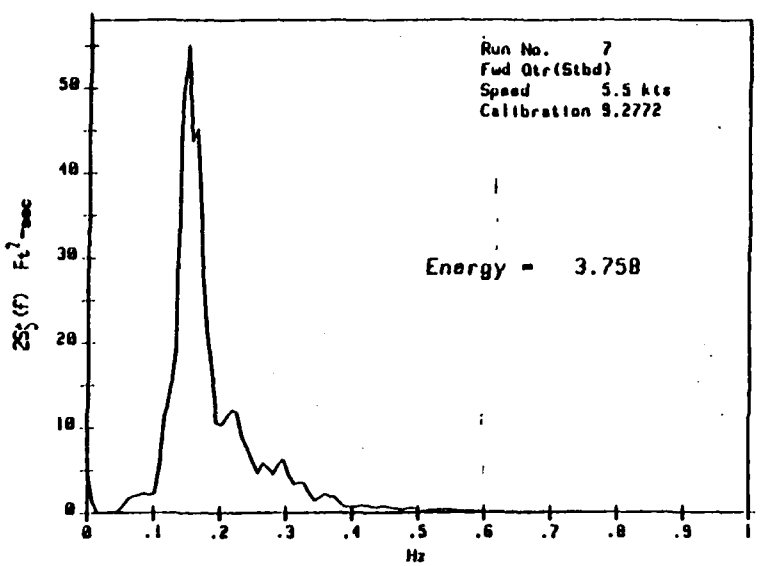
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



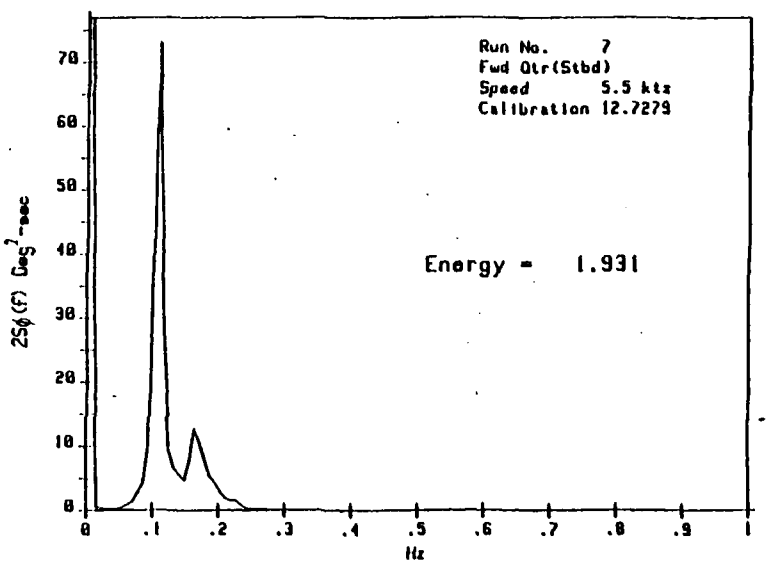
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81

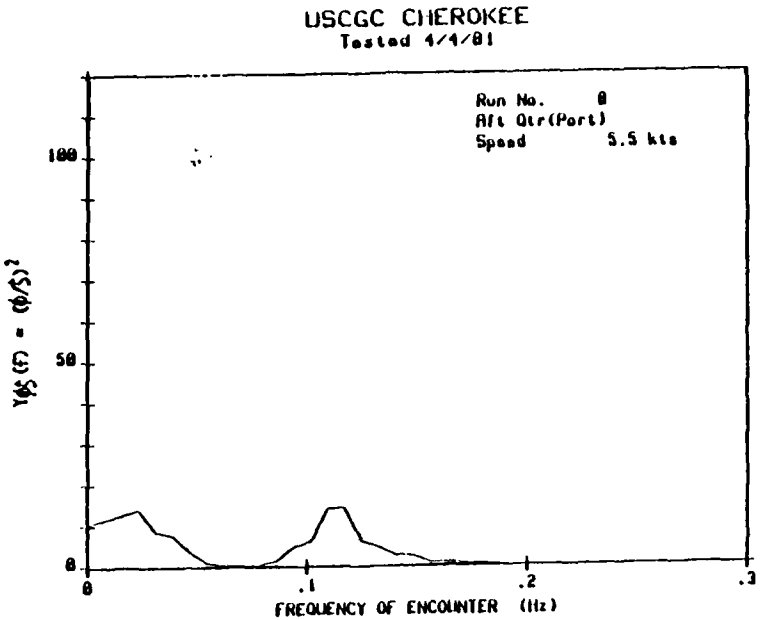


WAVE ENERGY SPECTRUM

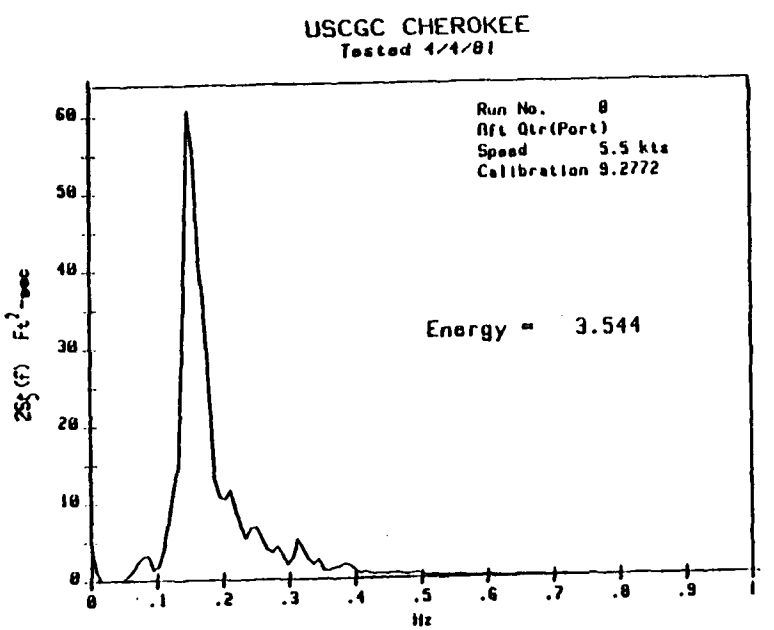
USCGC CHEROKEE
Tested 4/4/81



ROLL ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR



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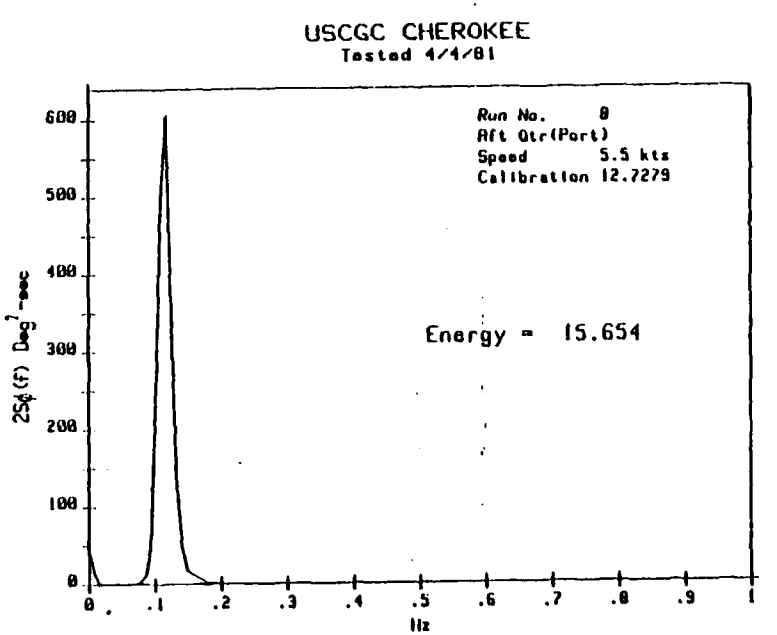
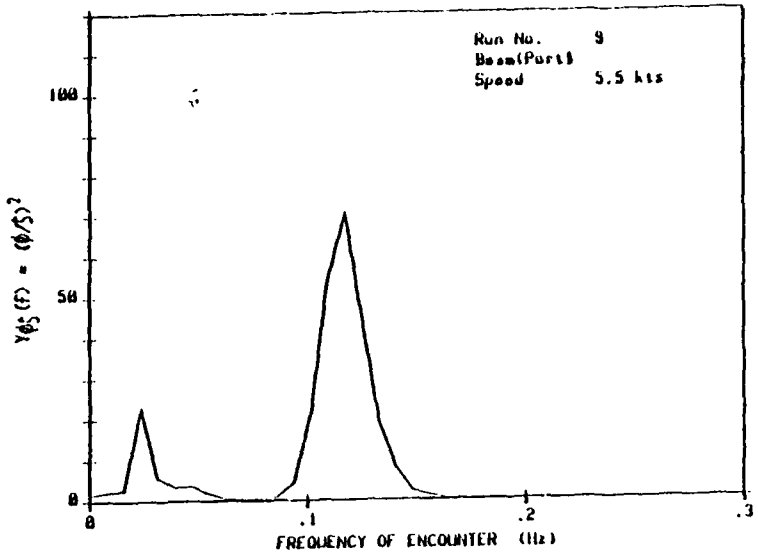


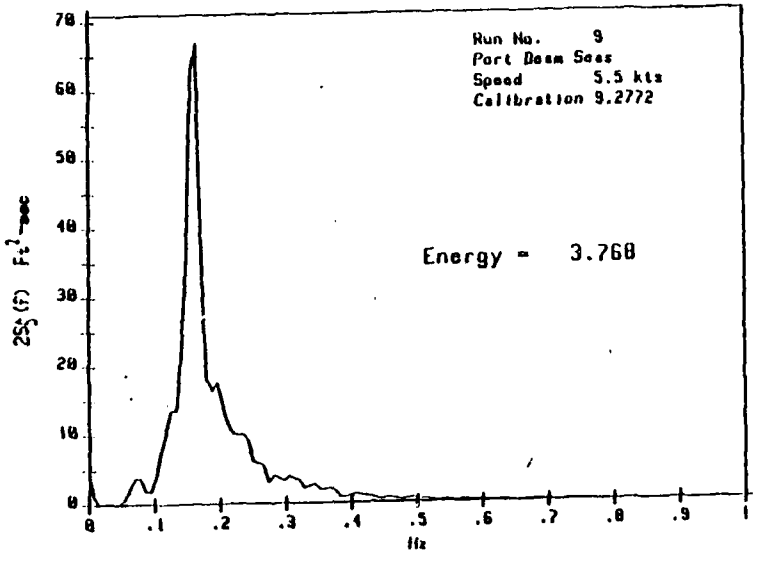
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



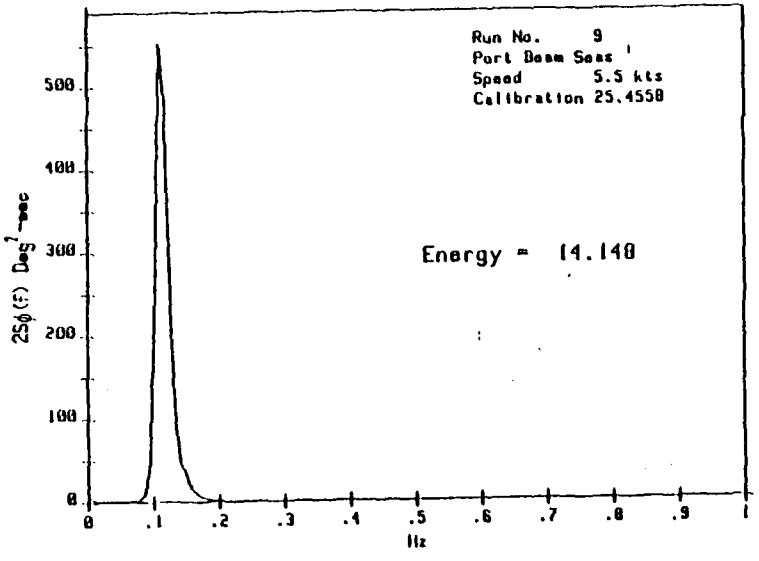
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81



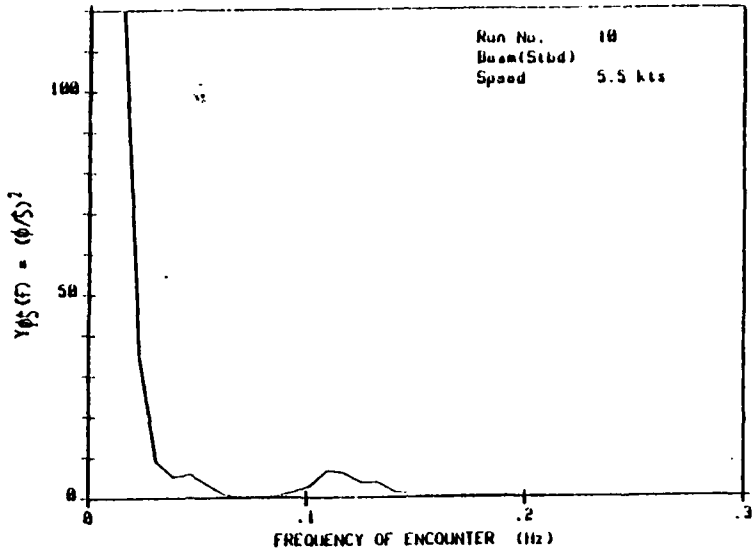
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



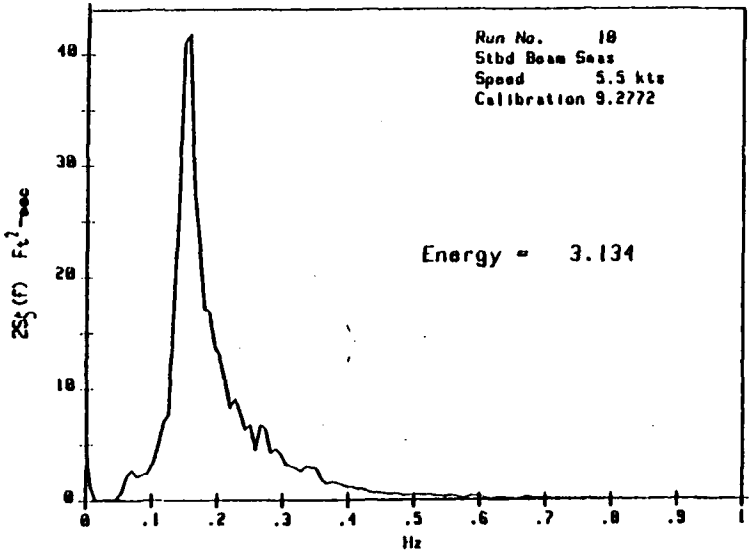
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



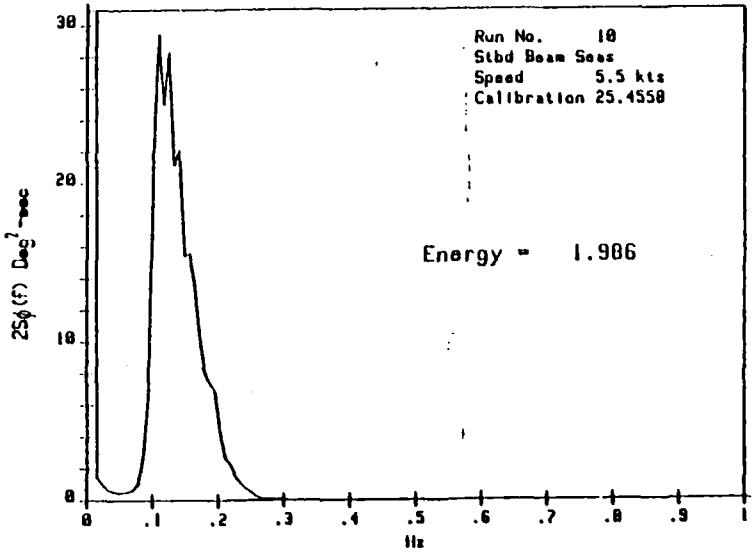
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81

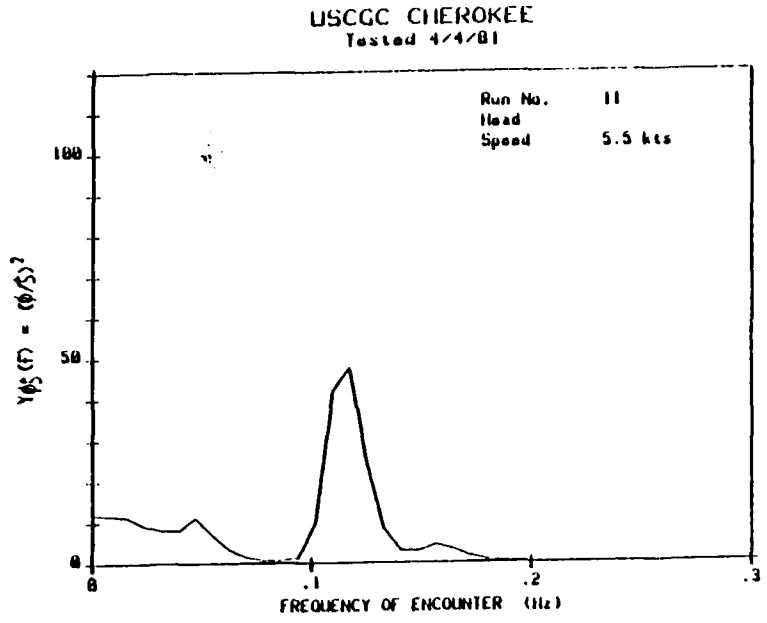


WAVE ENERGY SPECTRUM

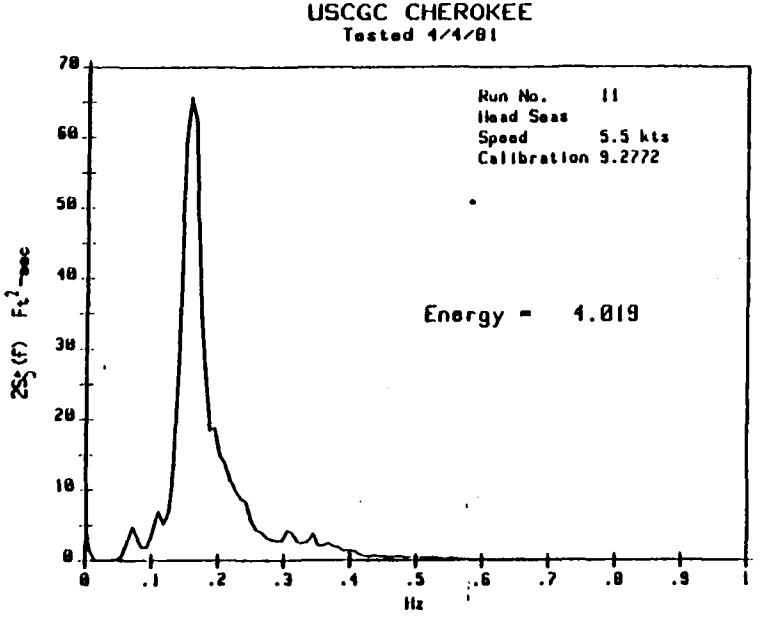
USCGC CHEROKEE
Tested 4/4/81



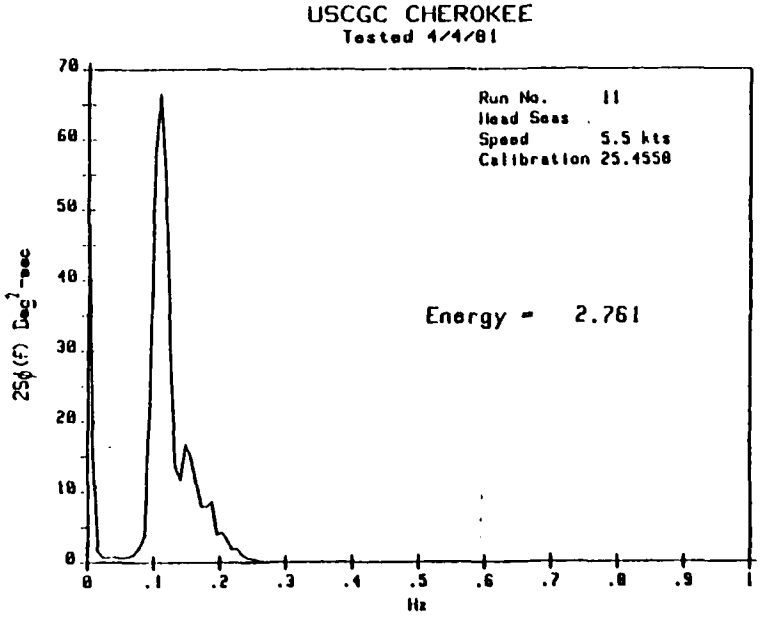
ROLL ENERGY SPECTRUM



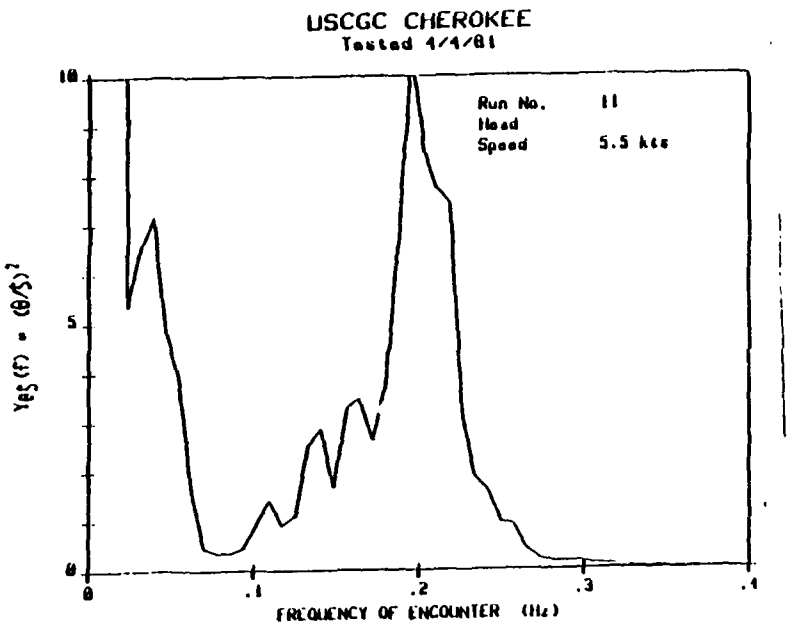
ROLL RESPONSE AMPLITUDE OPERATOR



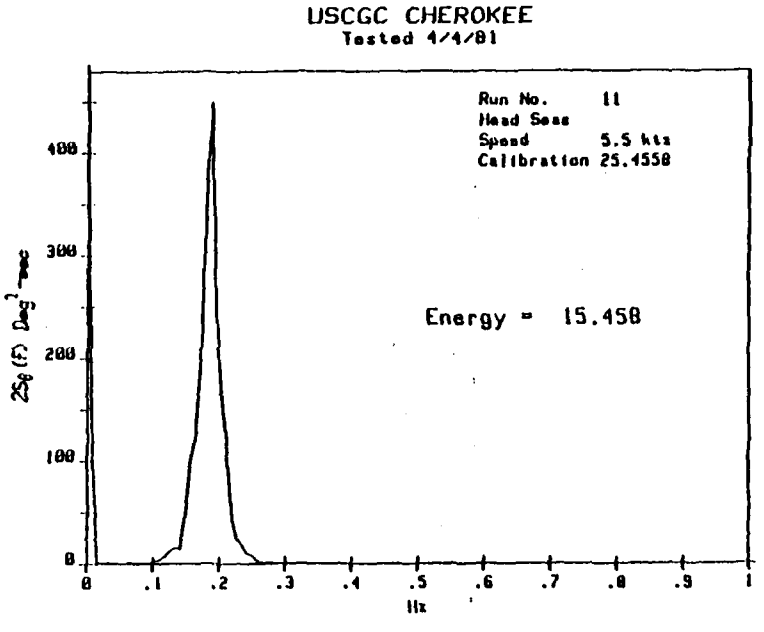
WAVE ENERGY SPECTRUM



ROLL ENERGY SPECTRUM

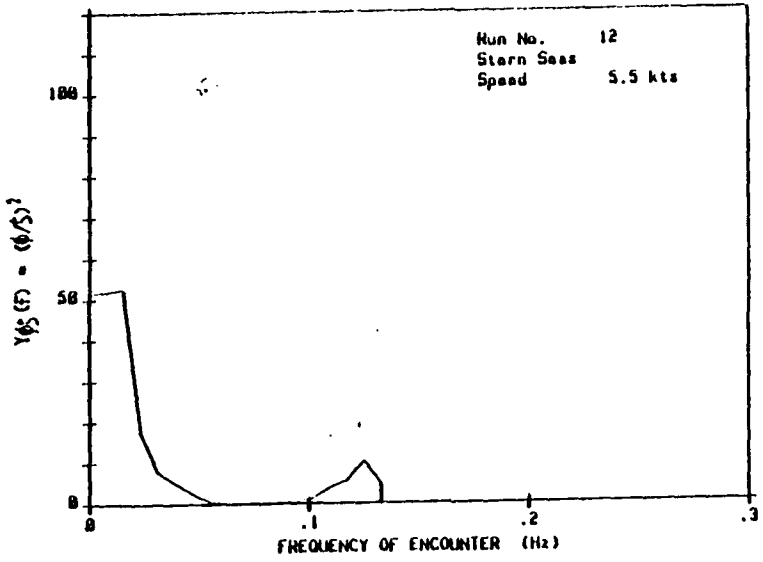


PITCH RESPONSE AMPLITUDE OPERATOR



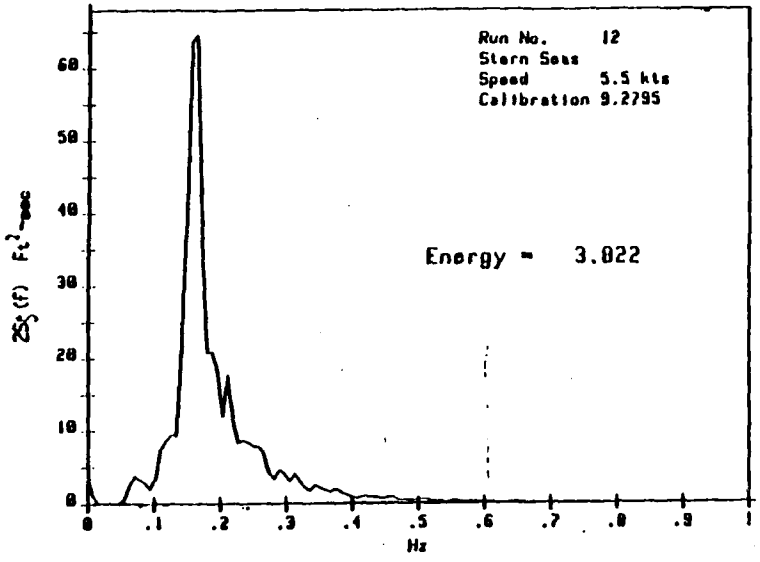
PITCH ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



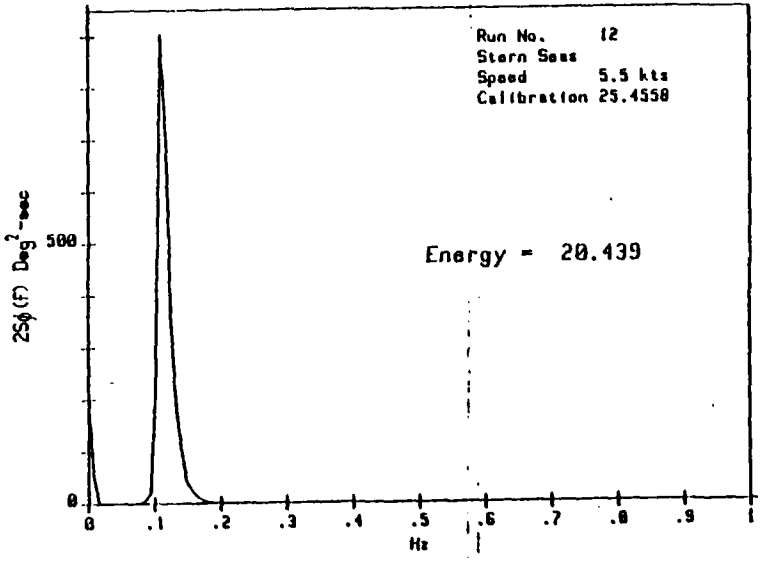
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81

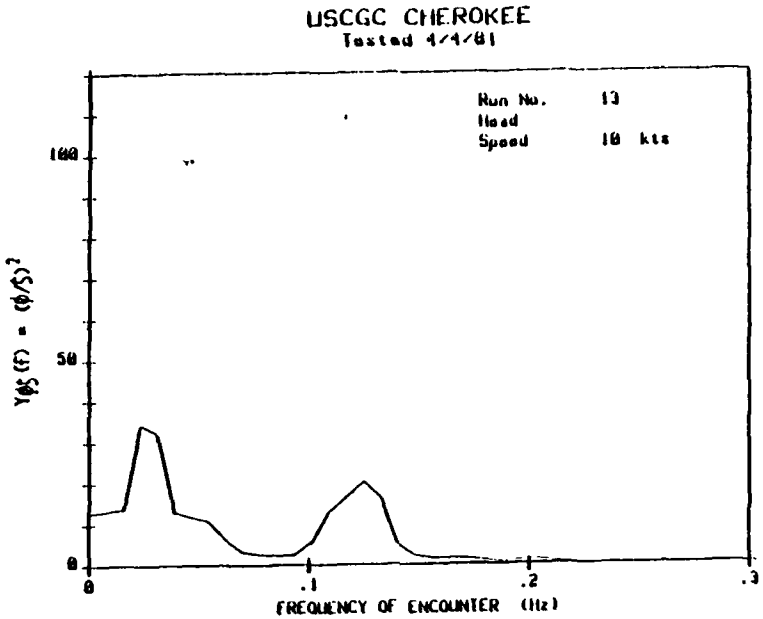


WAVE ENERGY SPECTRUM

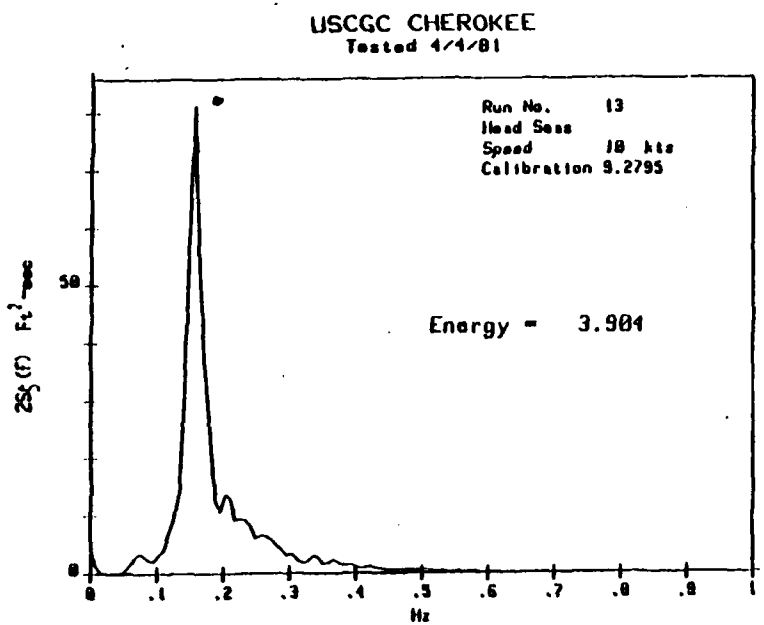
USCGC CHEROKEE
Tested 4/4/81



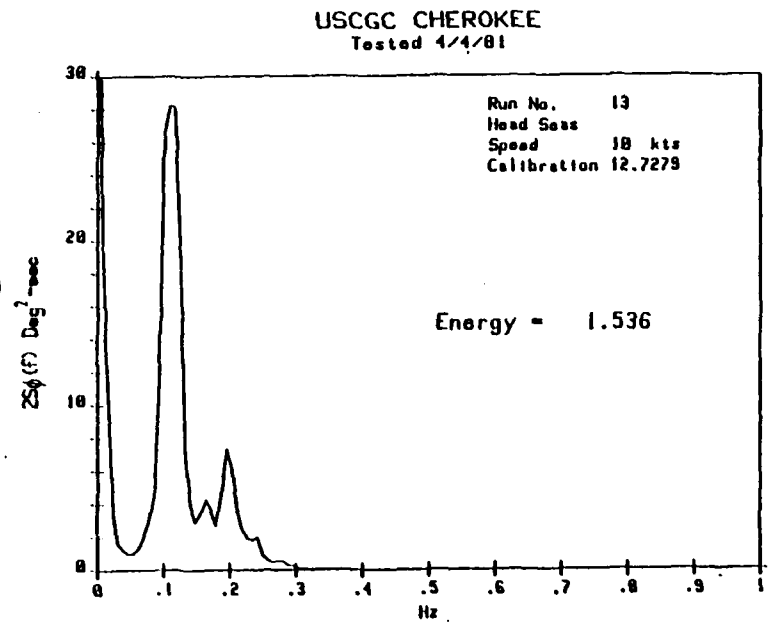
ROLL ENERGY SPECTRUM



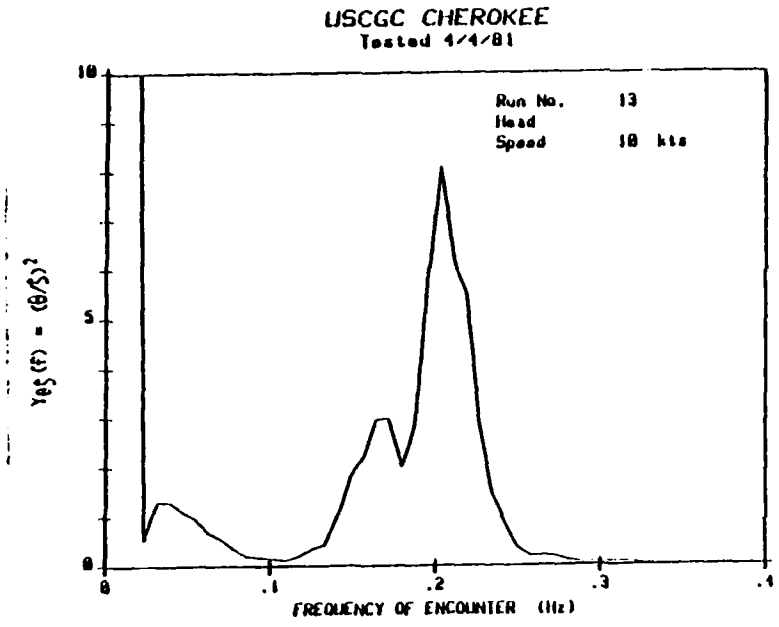
ROLL RESPONSE AMPLITUDE OPERATOR



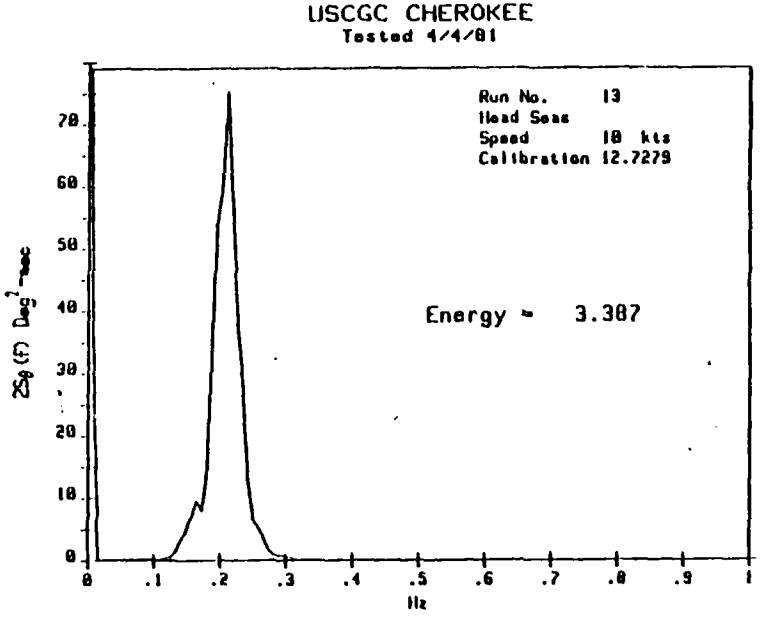
WAVE ENERGY SPECTRUM



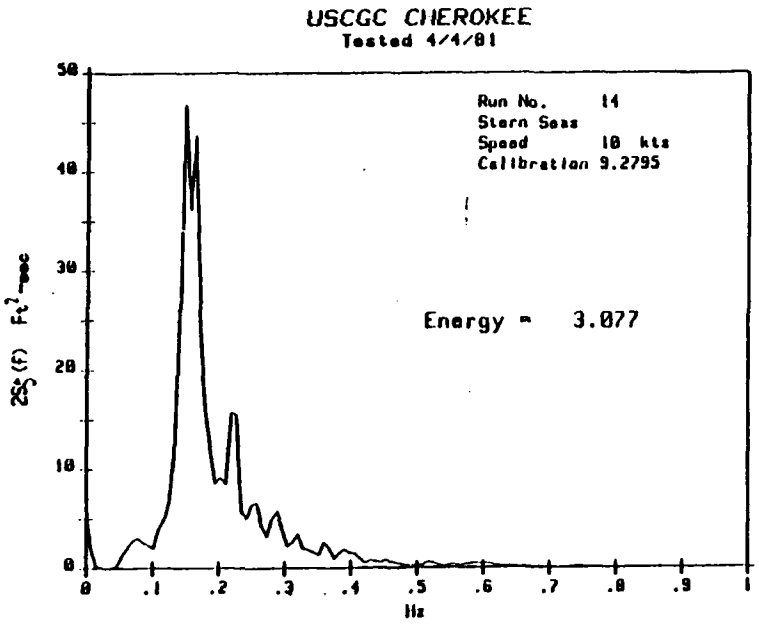
ROLL ENERGY SPECTRUM



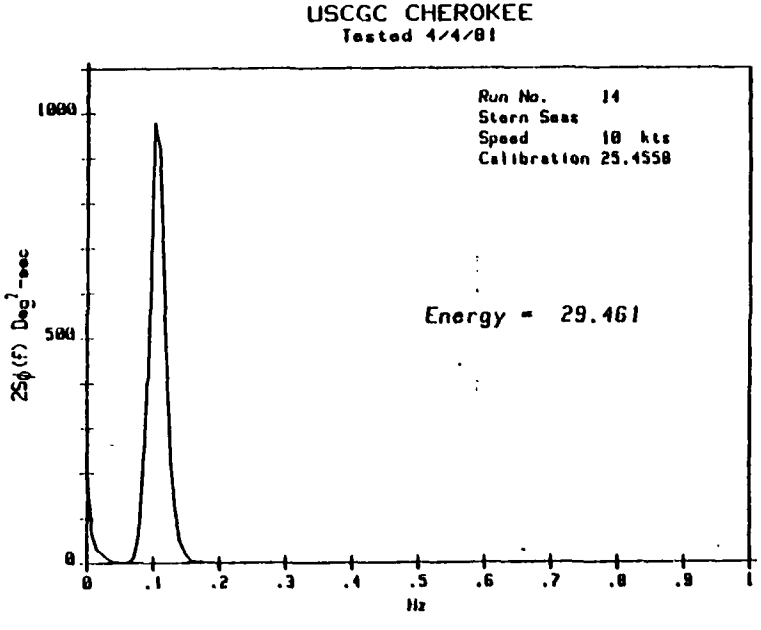
PITCH RESPONSE AMPLITUDE OPERATOR



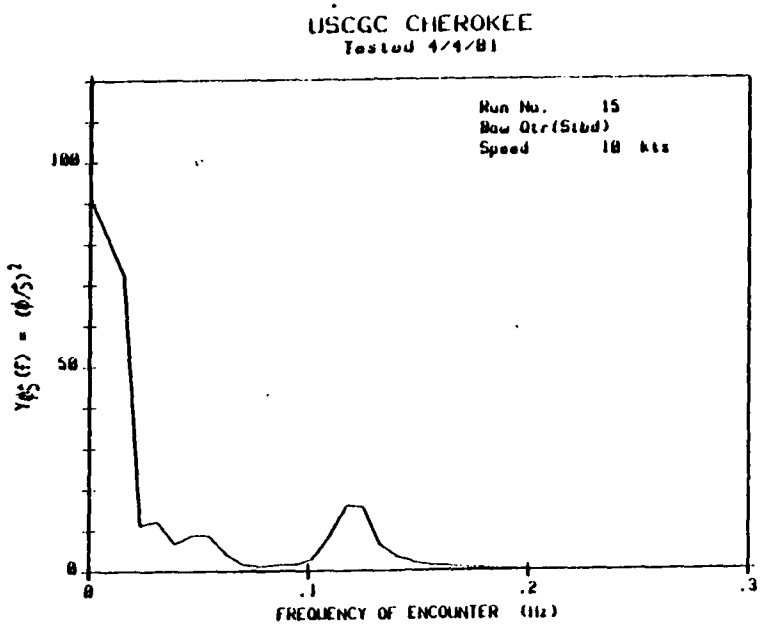
PITCH ENERGY SPECTRUM



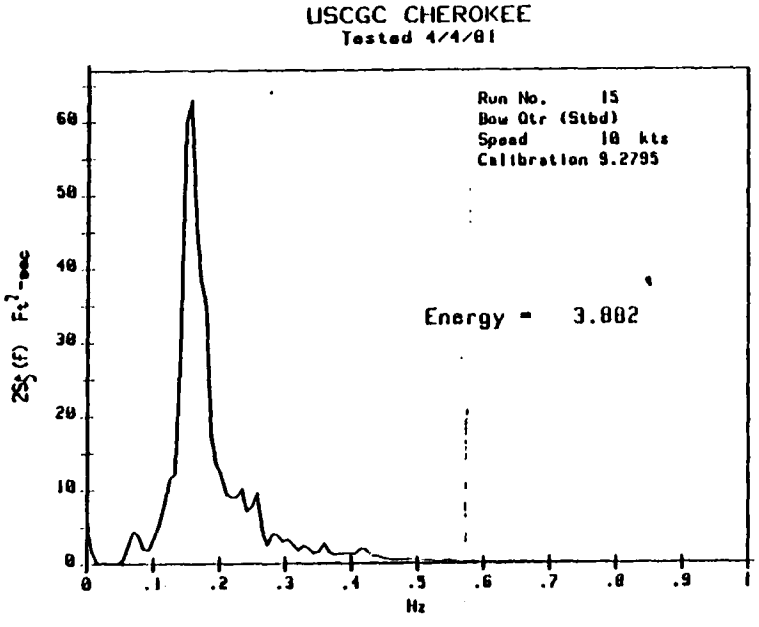
WAVE ENERGY SPECTRUM



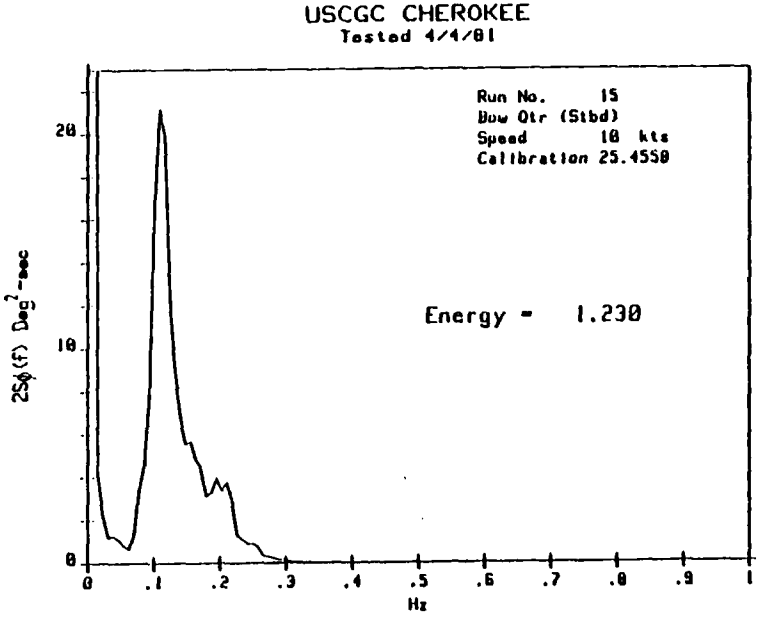
ROLL ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR

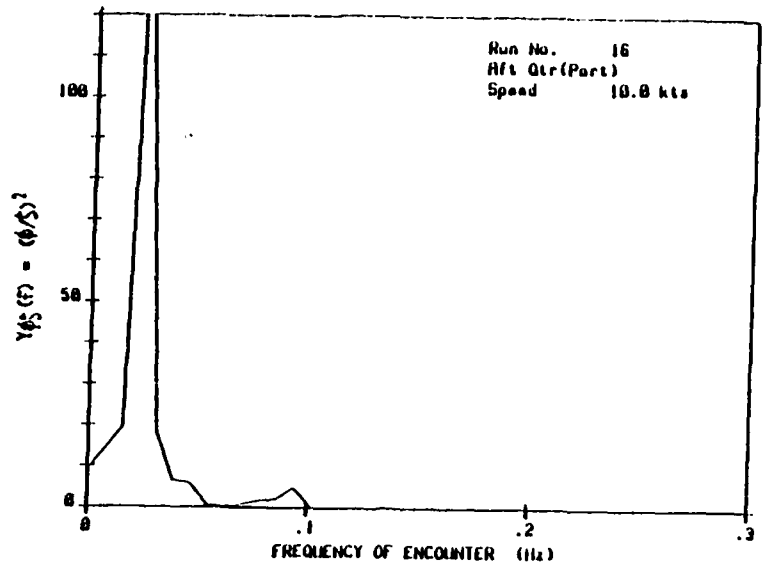


WAVE ENERGY SPECTRUM



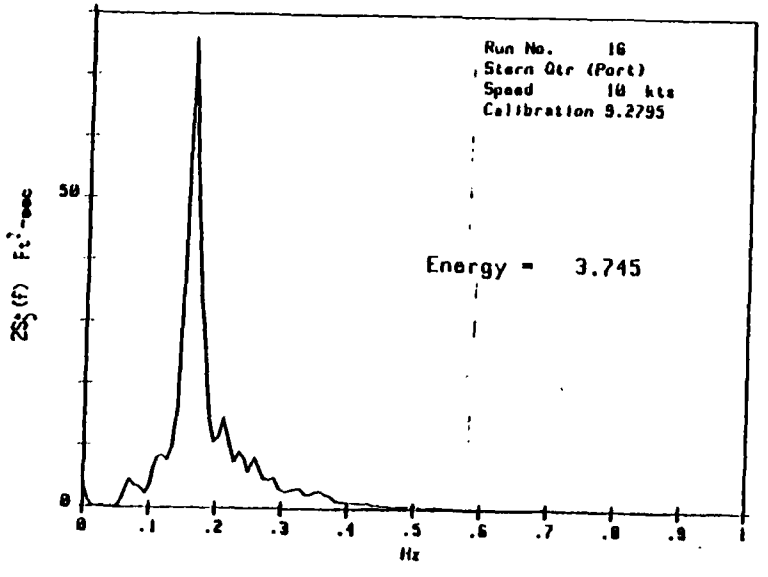
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



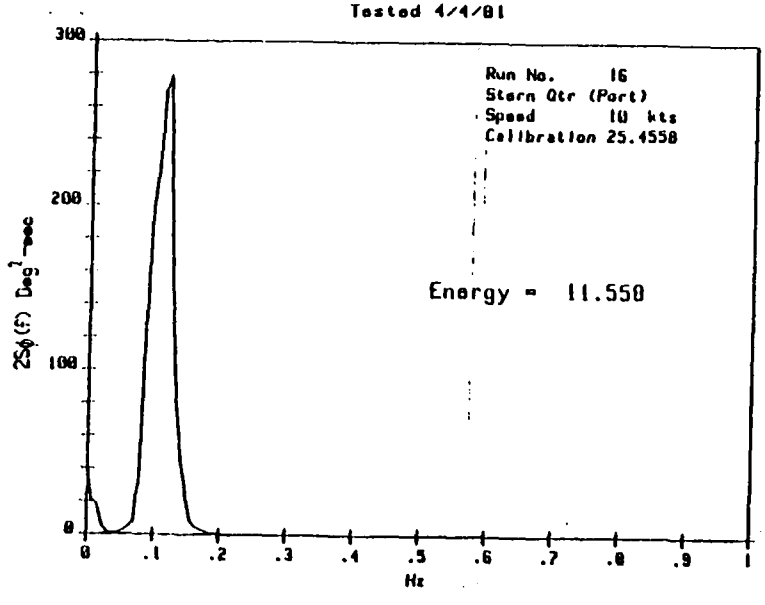
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81



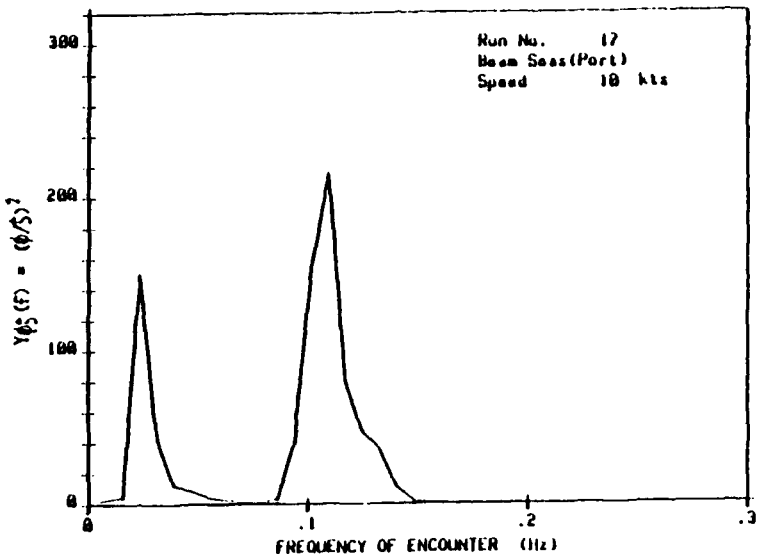
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



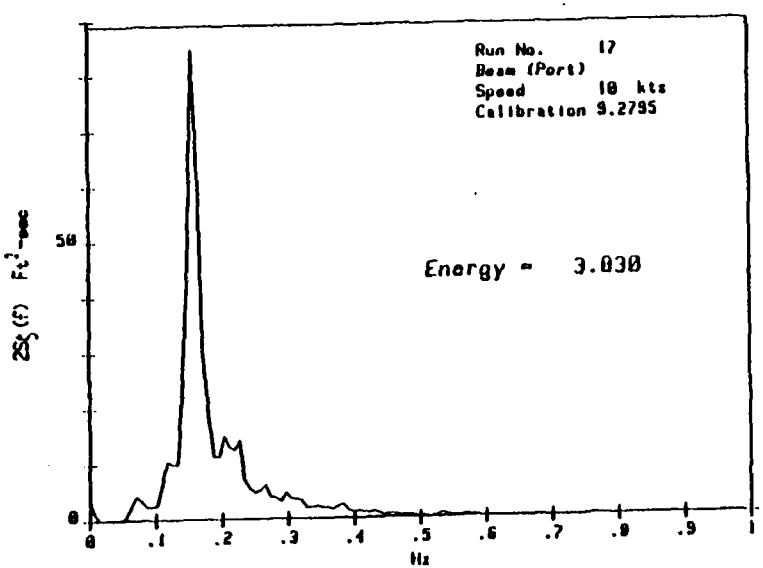
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



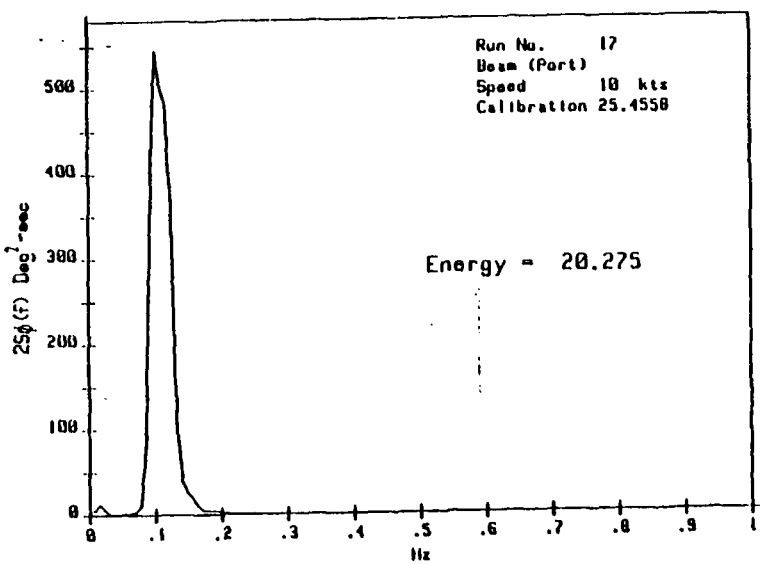
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81



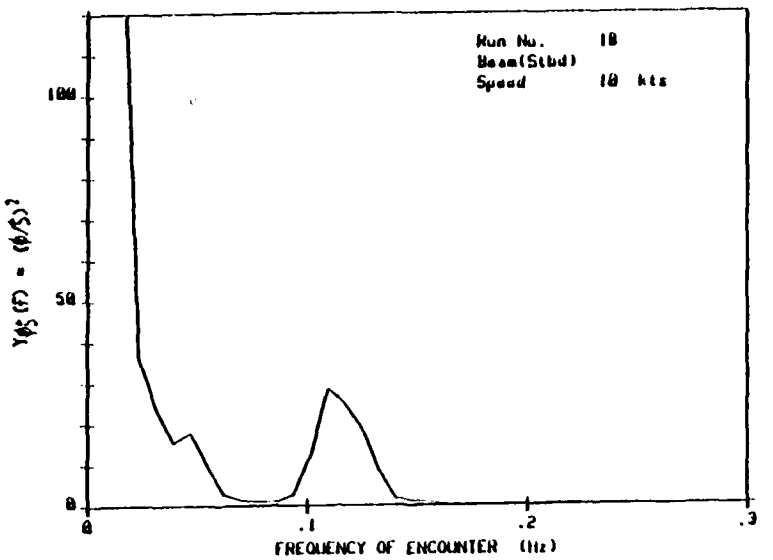
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



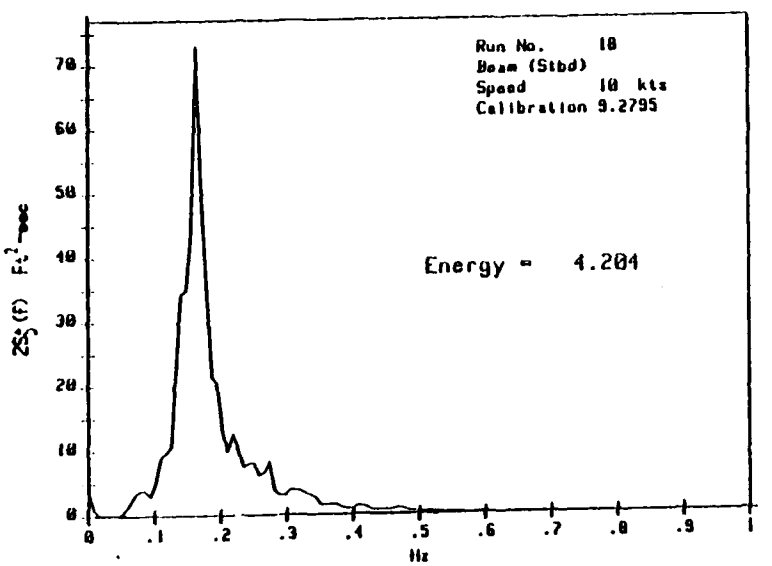
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/4/81



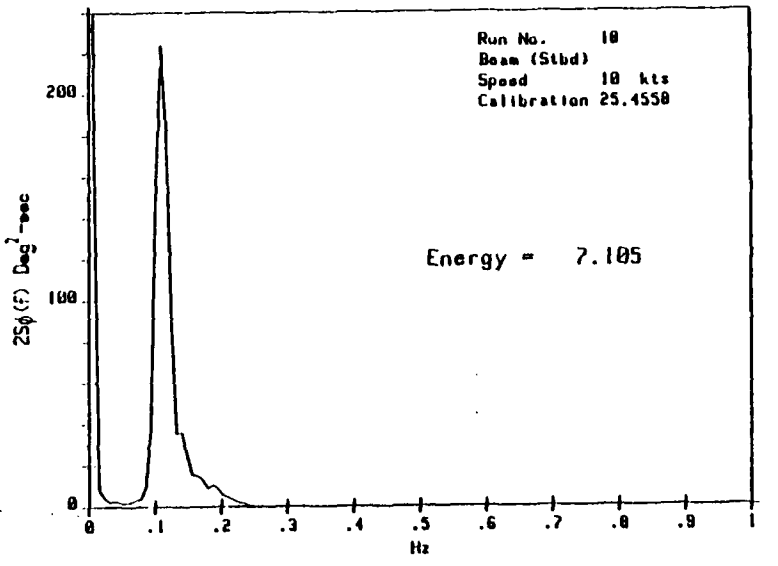
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/4/81

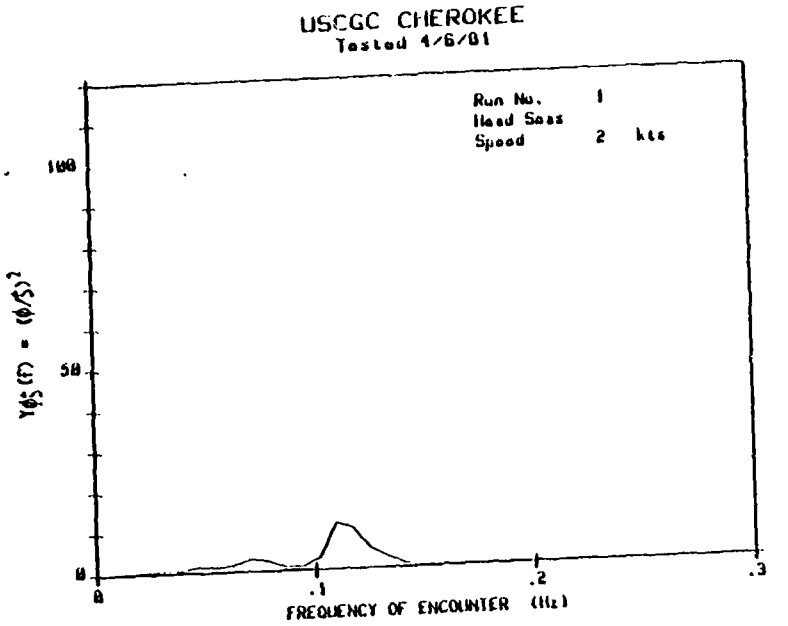


WAVE ENERGY SPECTRUM

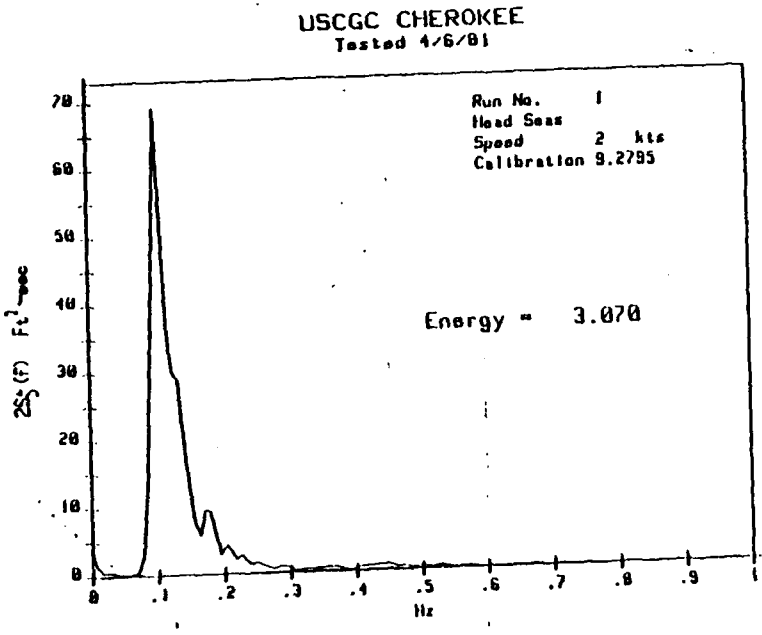
USCGC CHEROKEE
Tested 4/4/81



ROLL ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR



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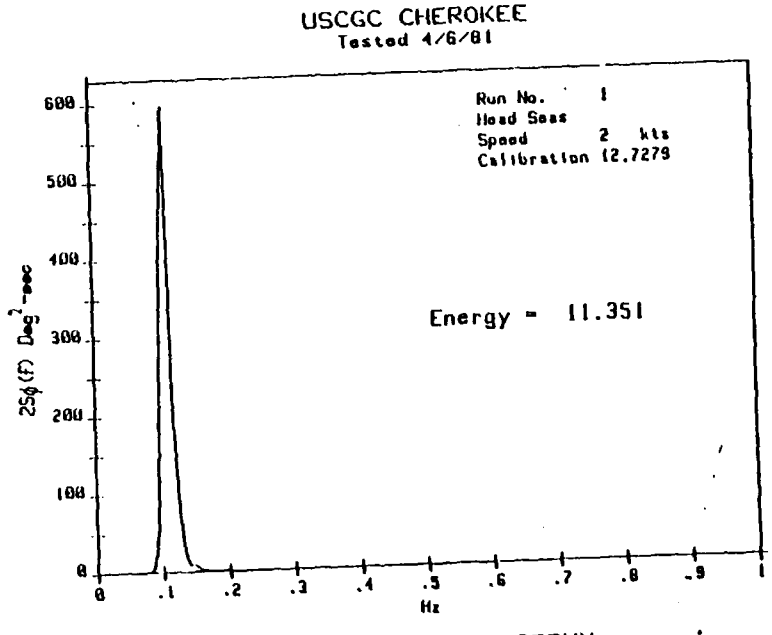
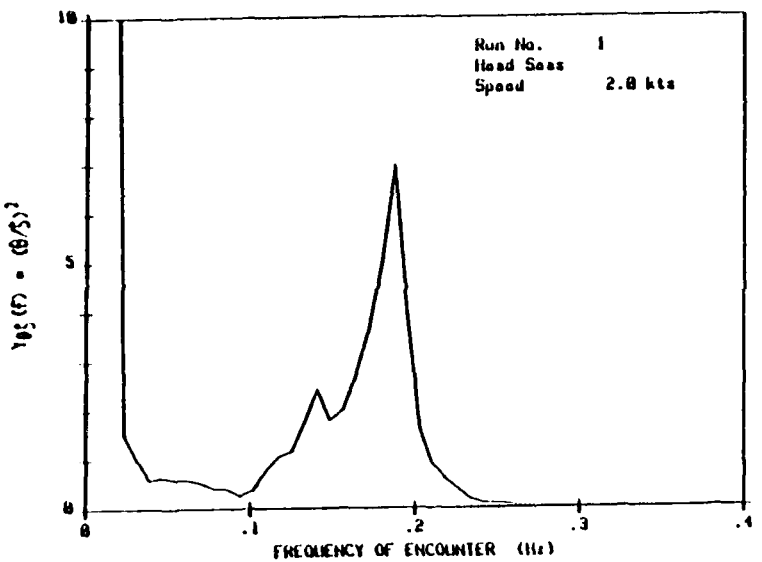


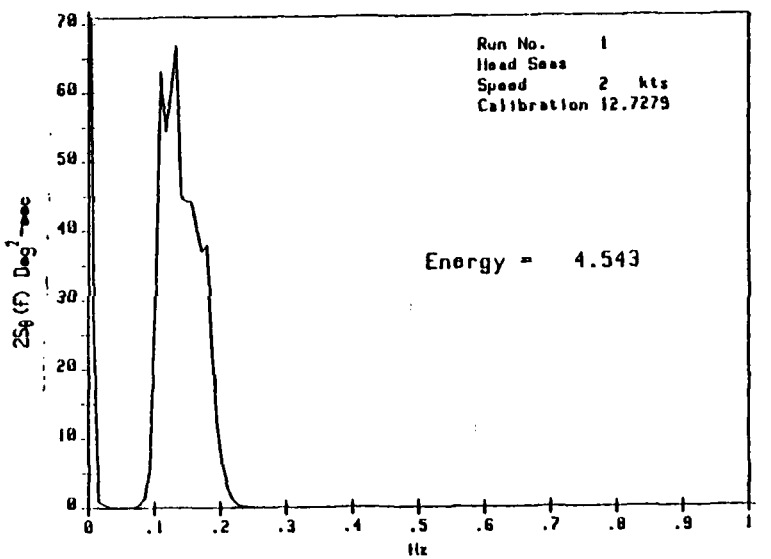
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



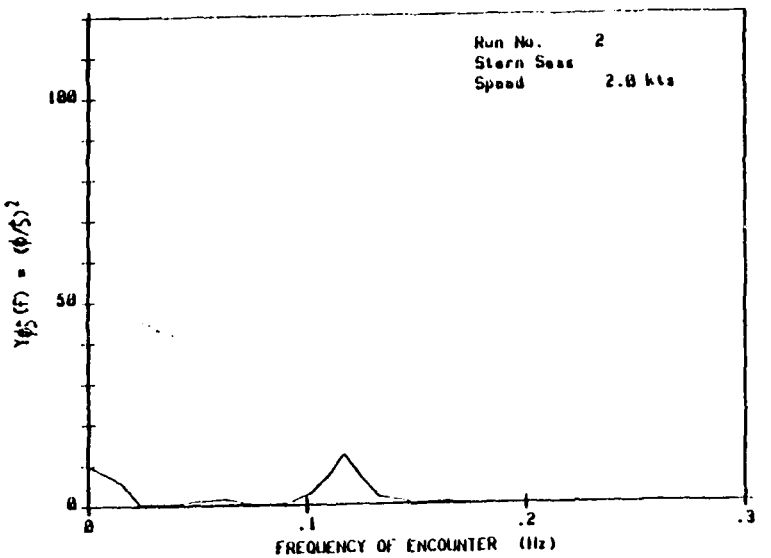
PITCH RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/6/81



PITCH ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



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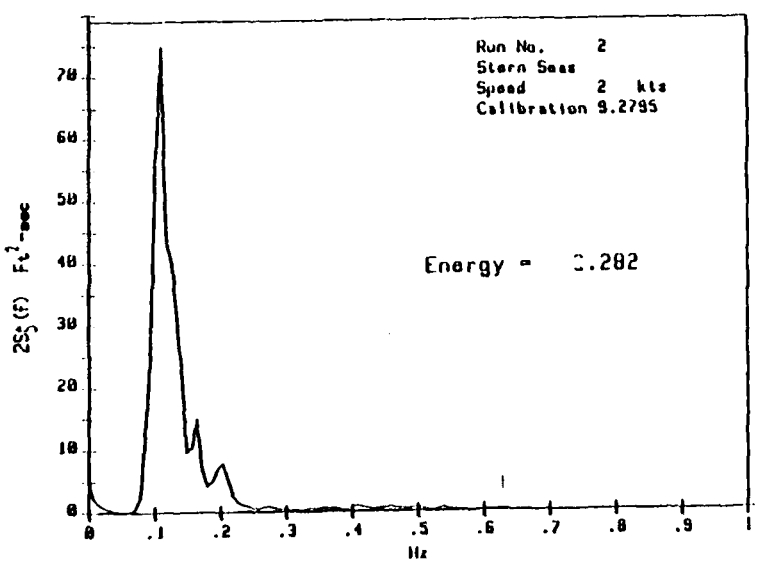
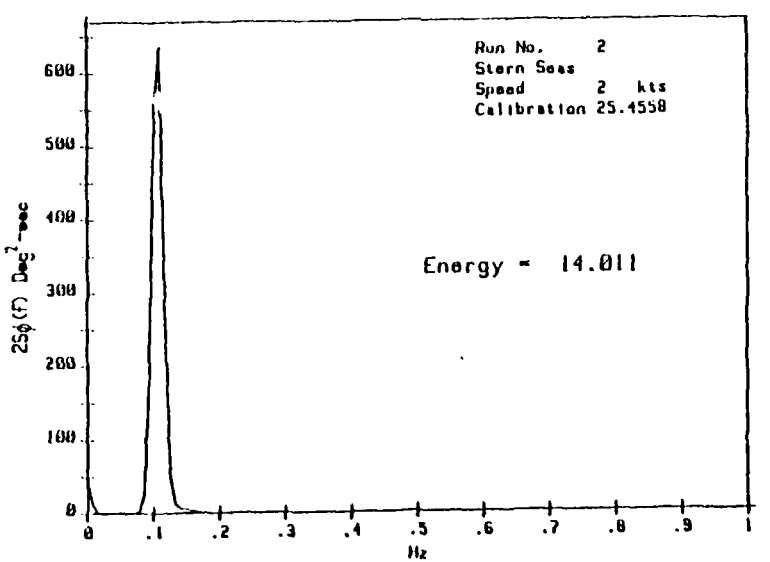
USCGC CHEROKEE
Tested 4/6/81

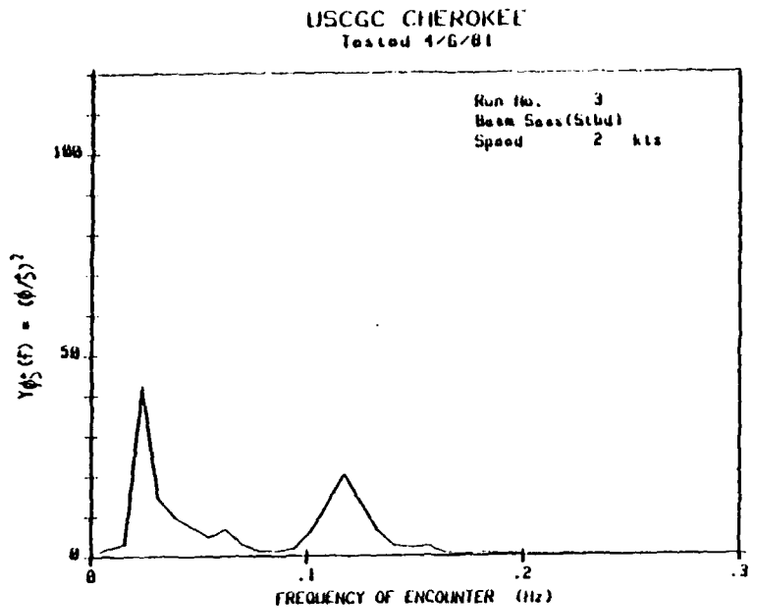


WAVE ENERGY SPECTRUM

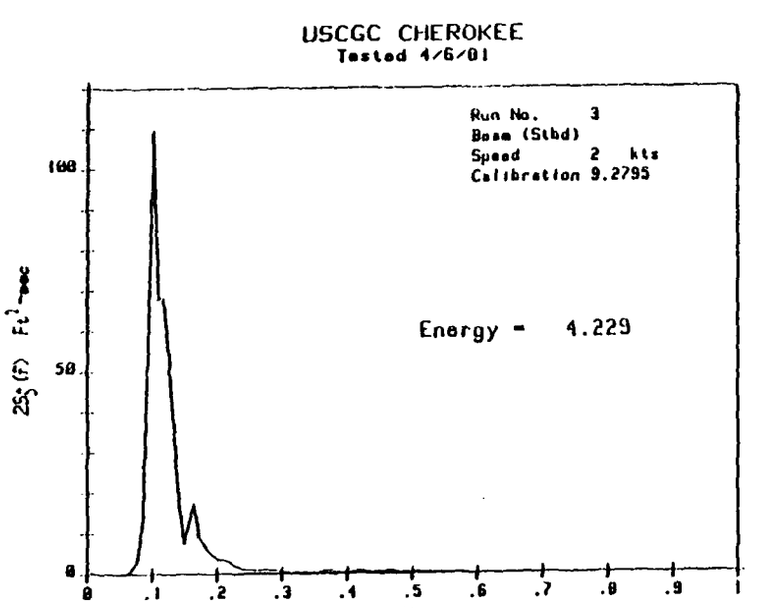
USCGC CHEROKEE
Tested 4/6/81



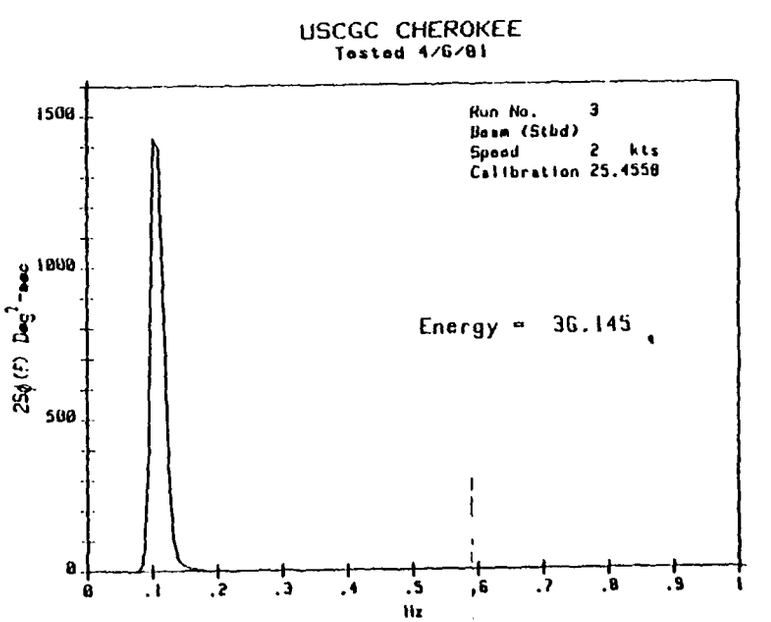
ROLL ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR

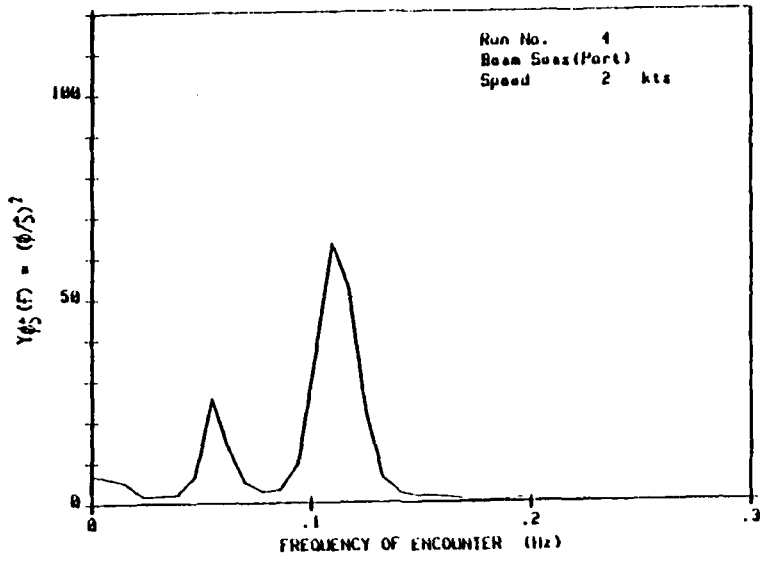


WAVE ENERGY SPECTRUM



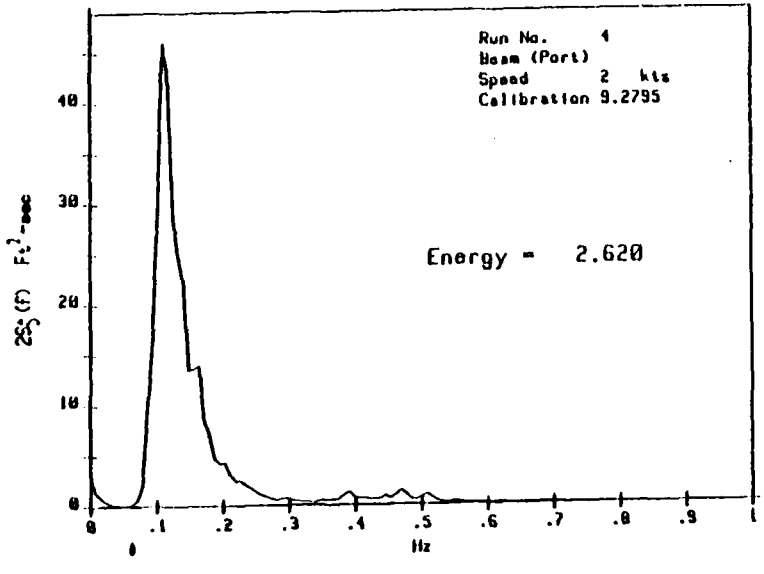
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



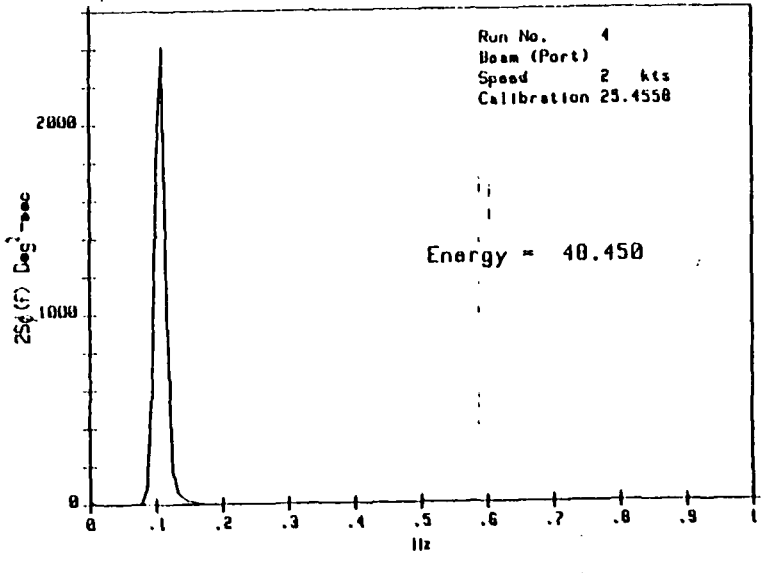
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/6/81

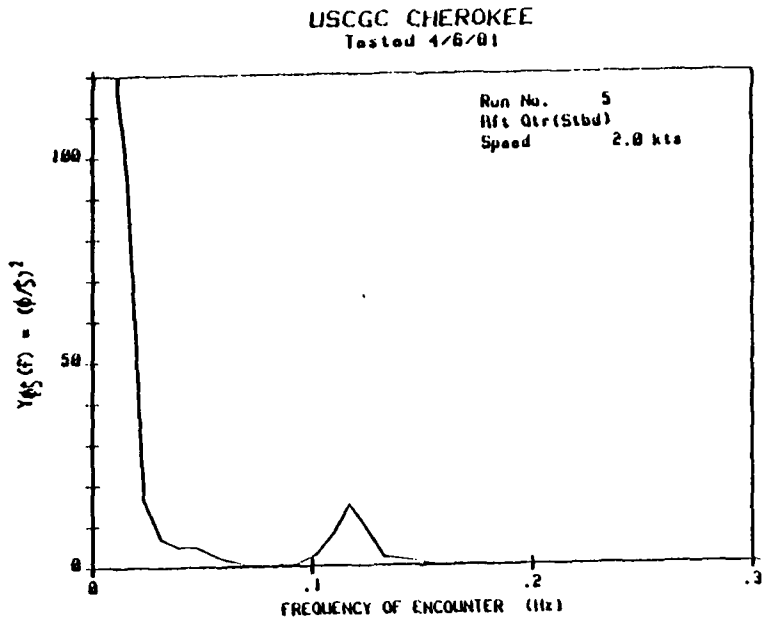


WAVE ENERGY SPECTRUM

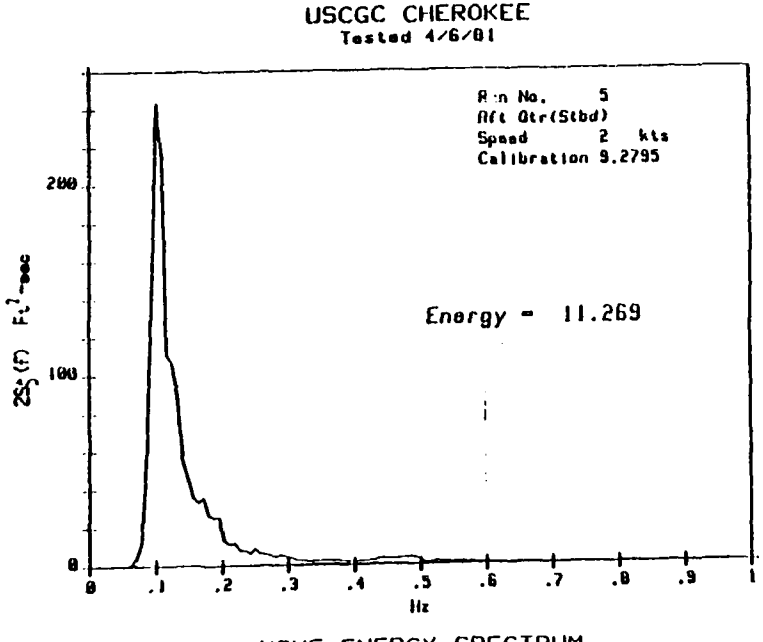
USCGC CHEROKEE
Tested 4/6/81



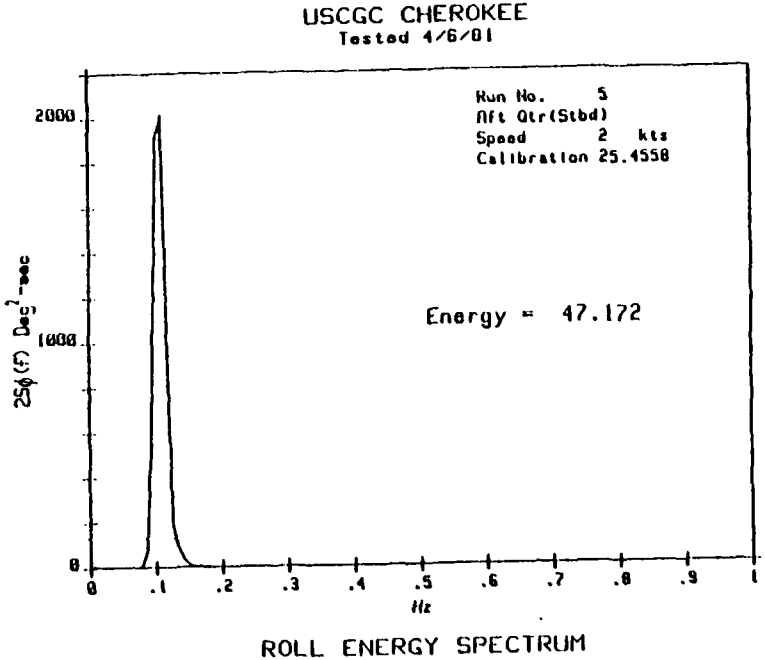
ROLL ENERGY SPECTRUM



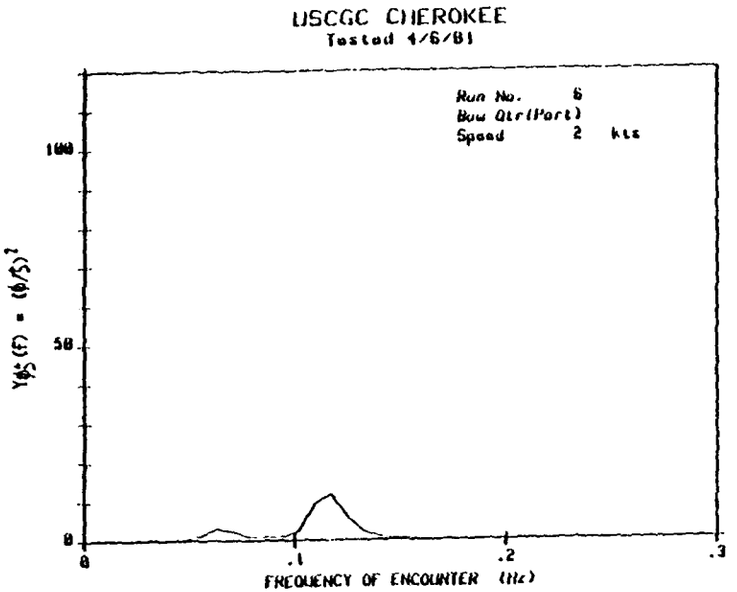
ROLL RESPONSE AMPLITUDE OPERATOR



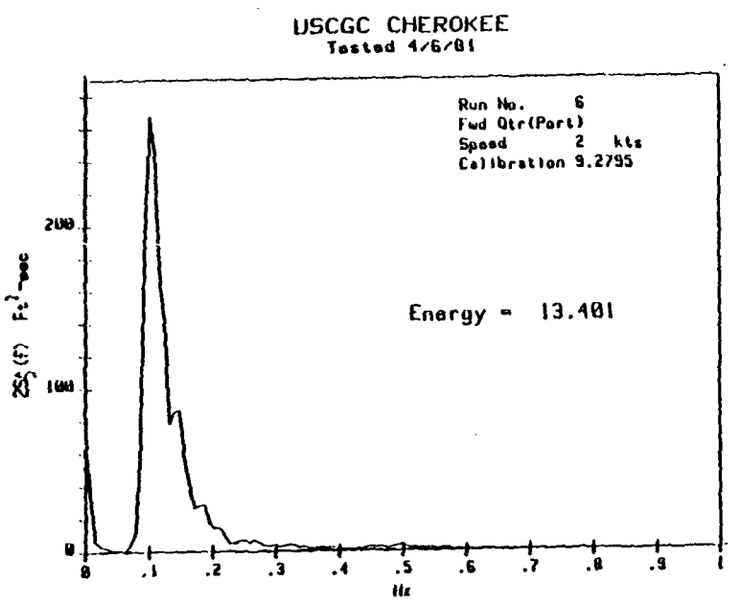
WAVE ENERGY SPECTRUM



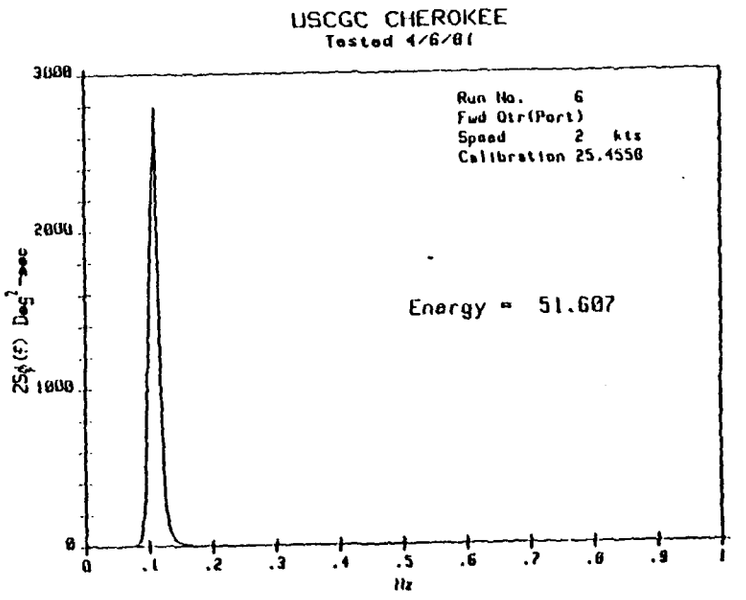
ROLL ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR



WAVE ENERGY SPECTRUM



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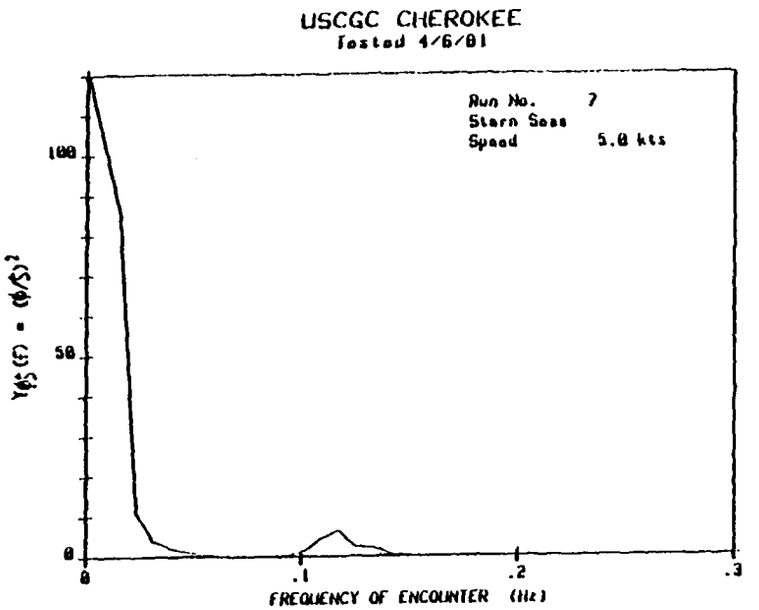
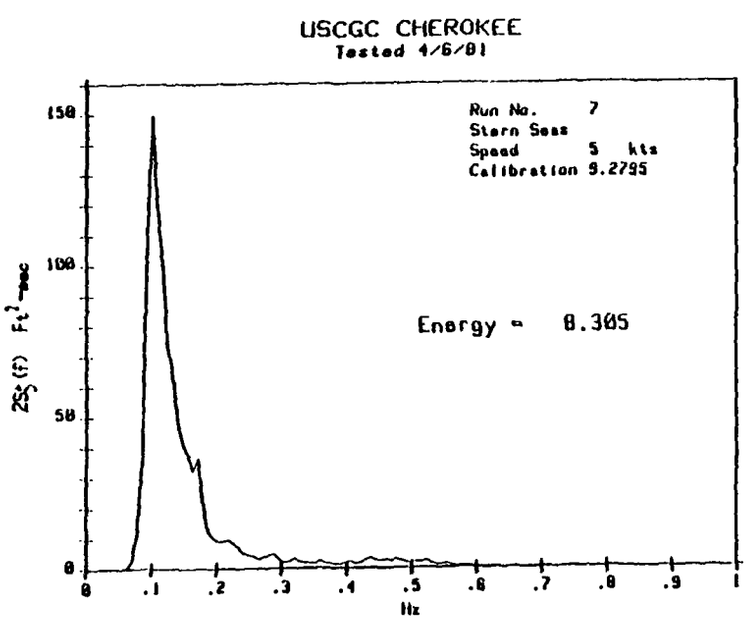
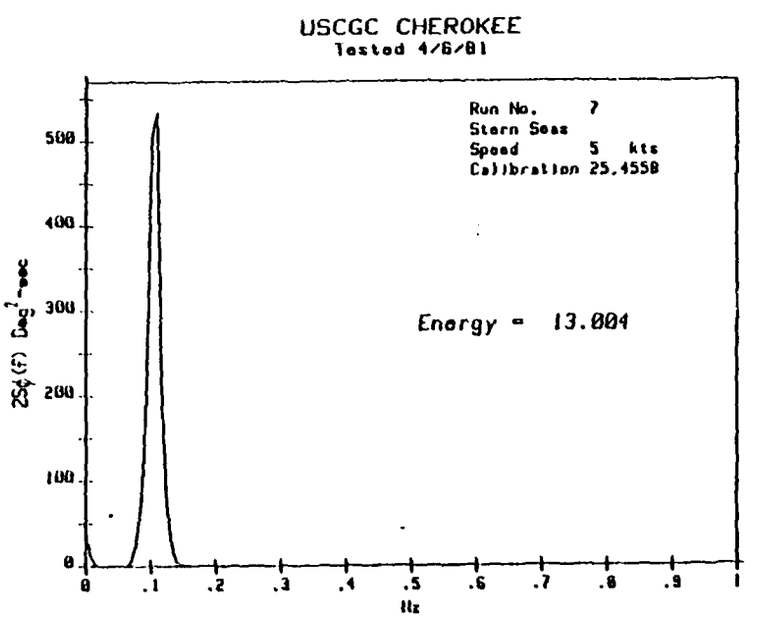


ROLL RESPONSE AMPLITUDE OPERATOR

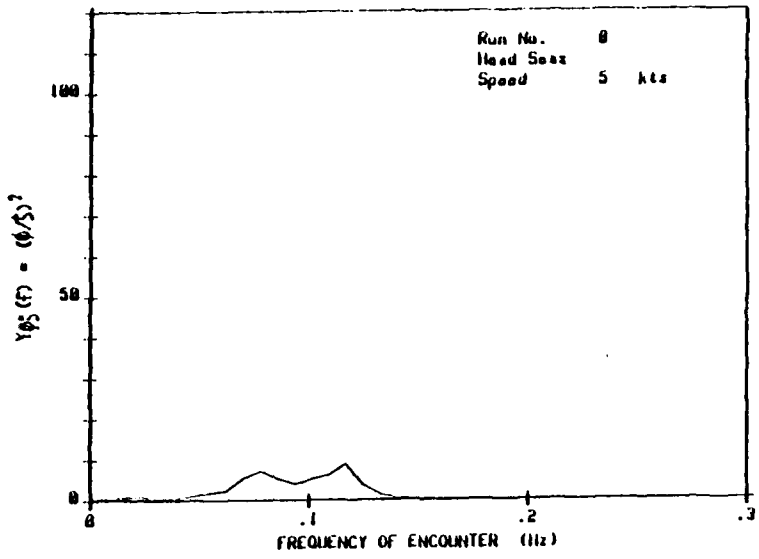


WAVE ENERGY SPECTRUM



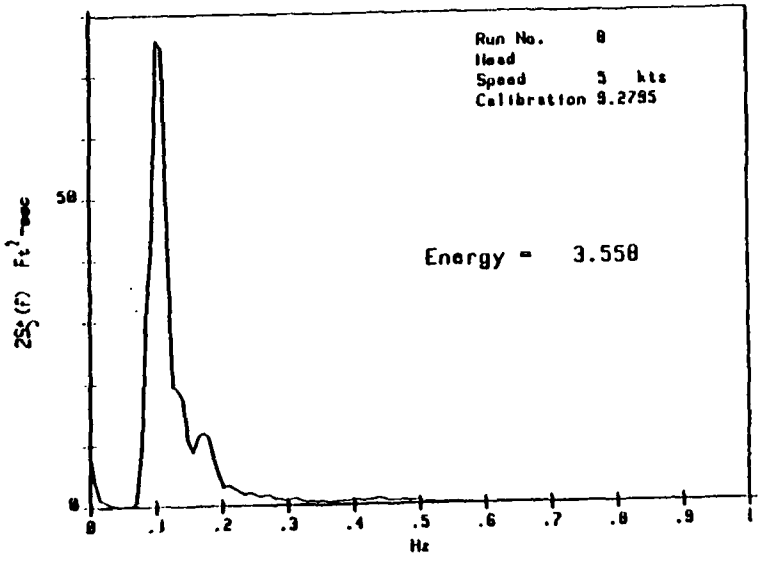
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



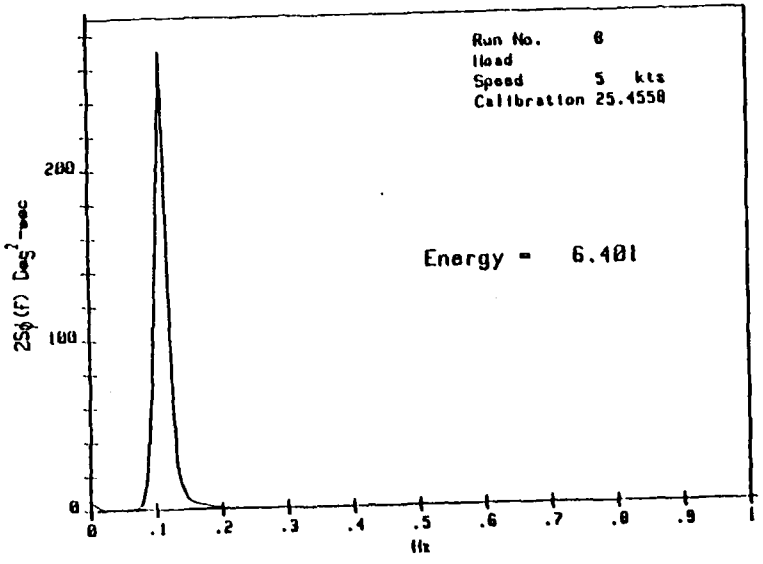
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/6/81

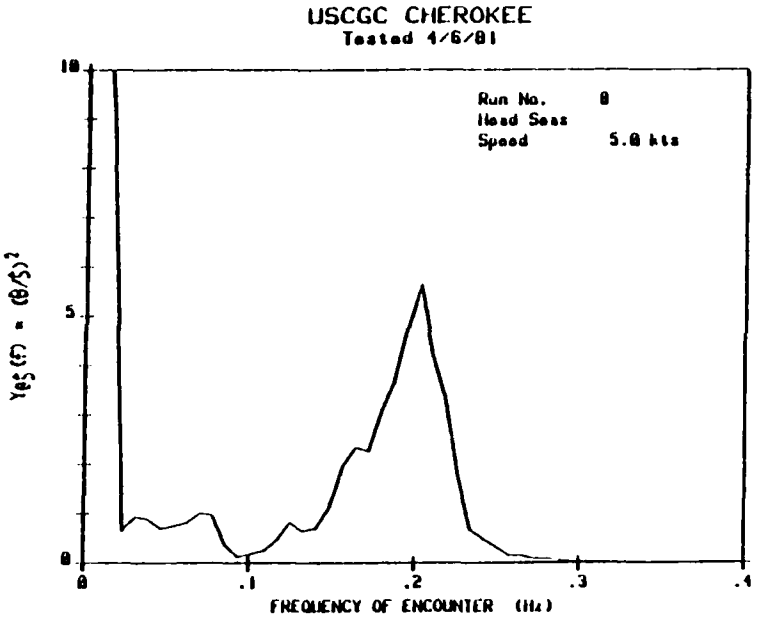


WAVE ENERGY SPECTRUM

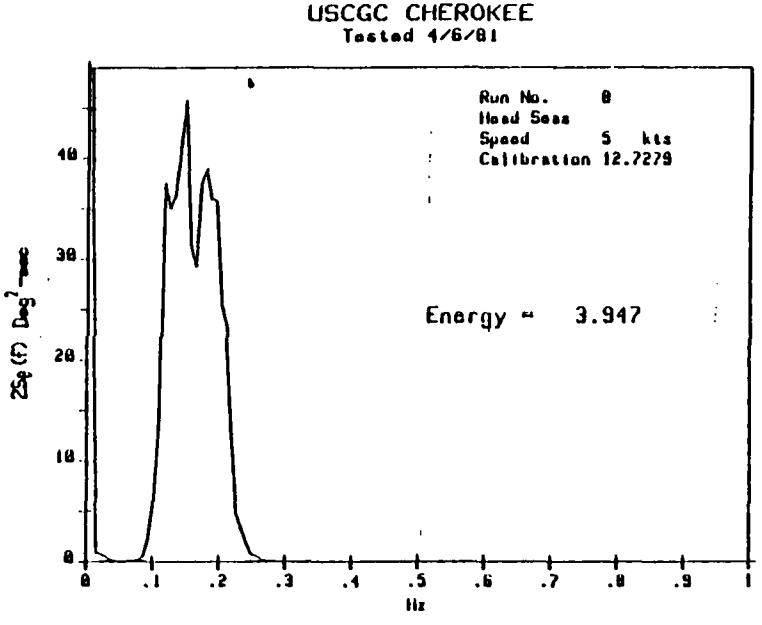
USCGC CHEROKEE
Tested 4/6/81



ROLL ENERGY SPECTRUM

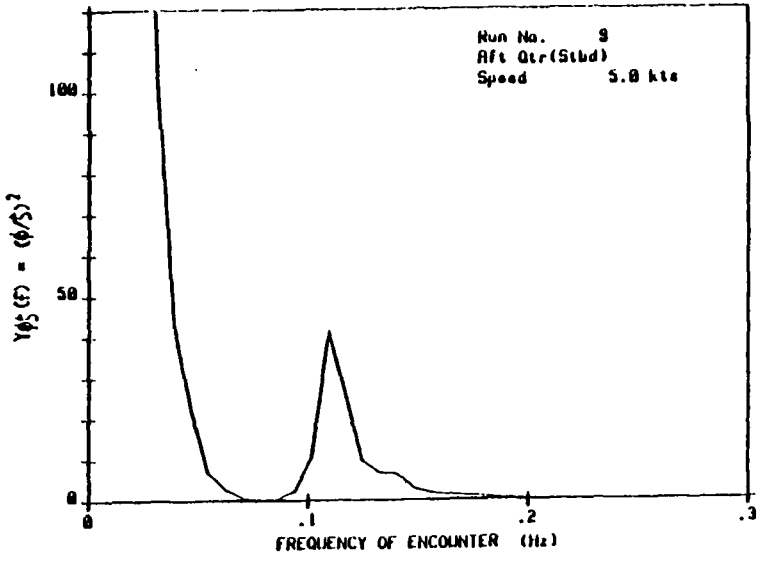


PITCH RESPONSE AMPLITUDE OPERATOR



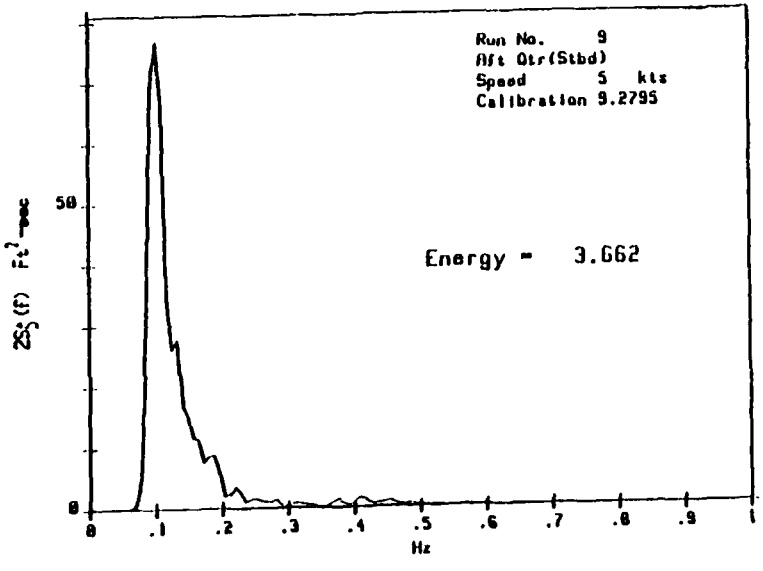
PITCH ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



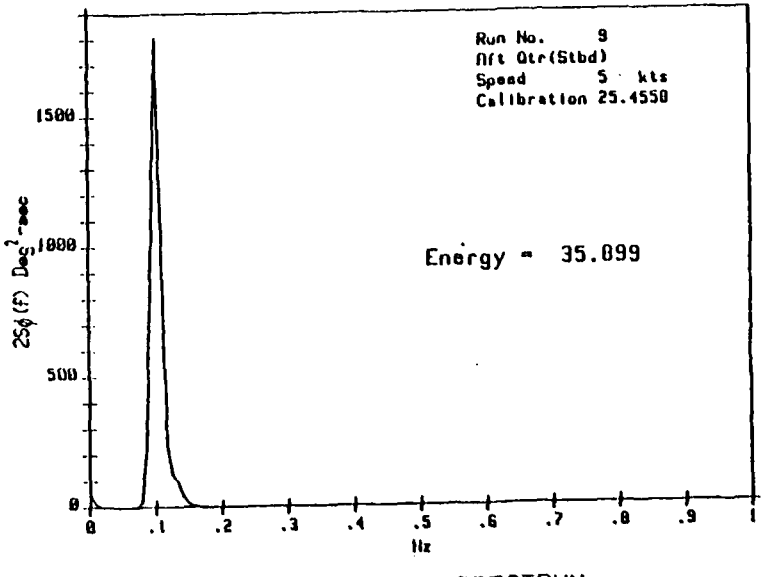
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/6/81

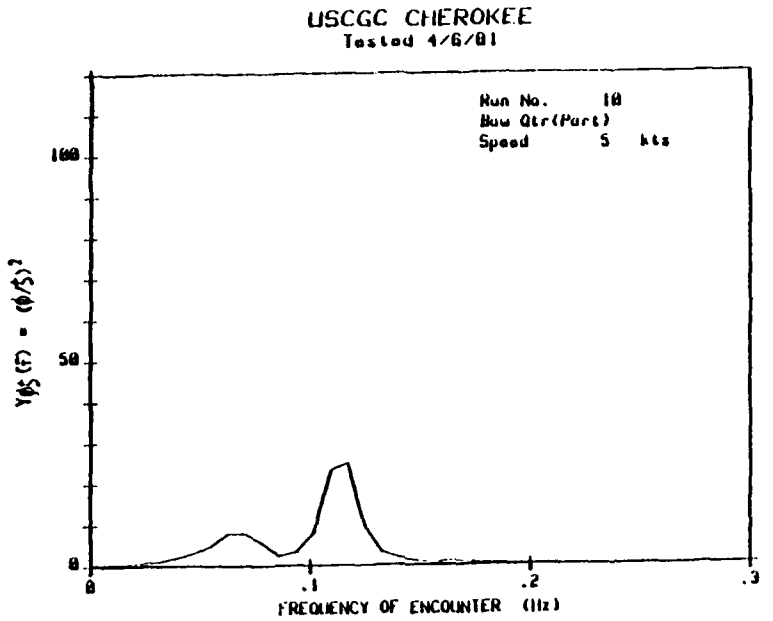


WAVE ENERGY SPECTRUM

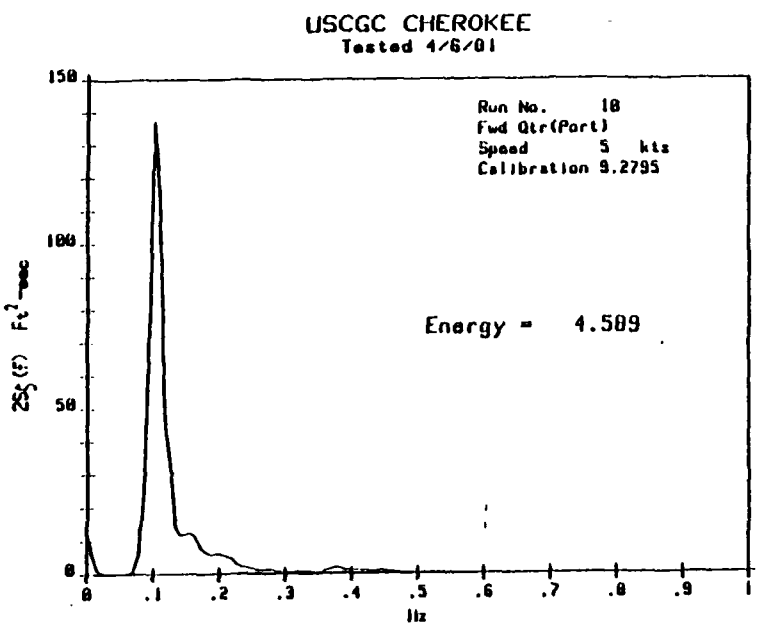
USCGC CHEROKEE
Tested 4/6/81



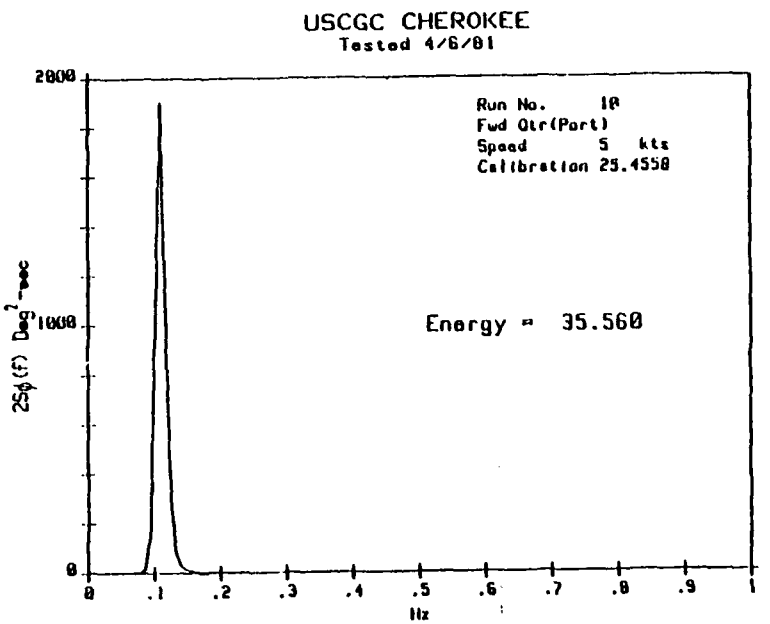
ROLL ENERGY SPECTRUM



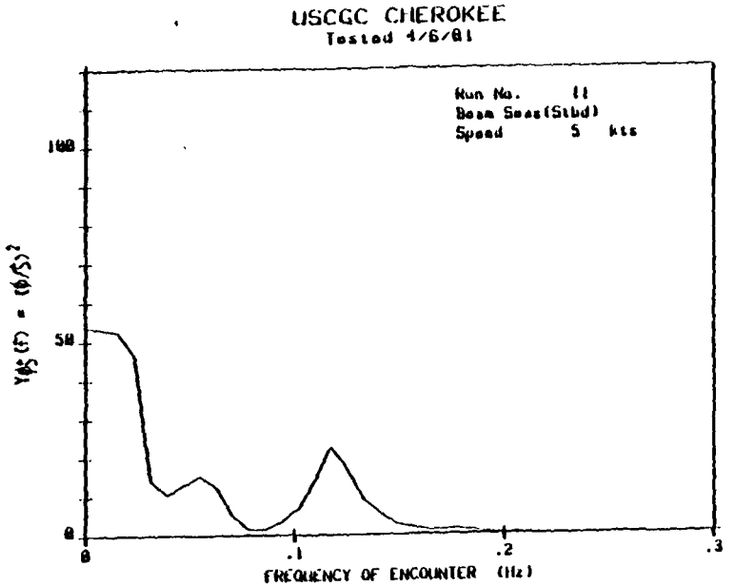
ROLL RESPONSE AMPLITUDE OPERATOR



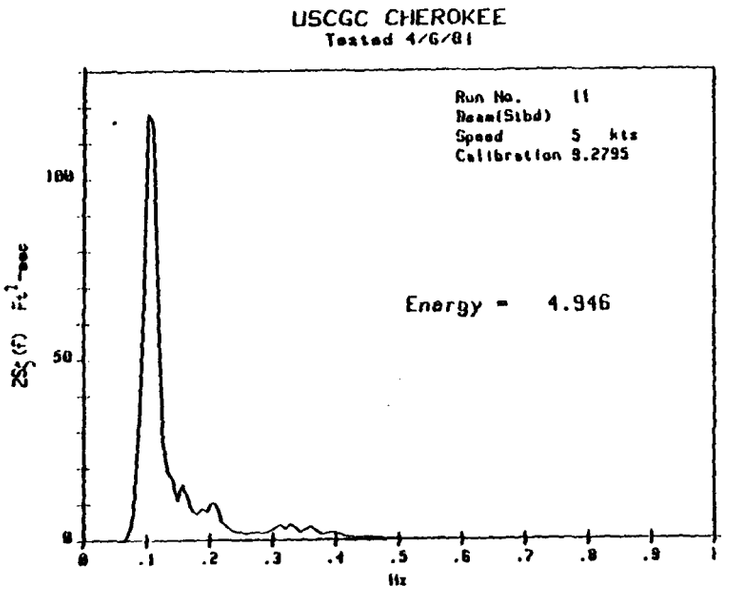
WAVE ENERGY SPECTRUM



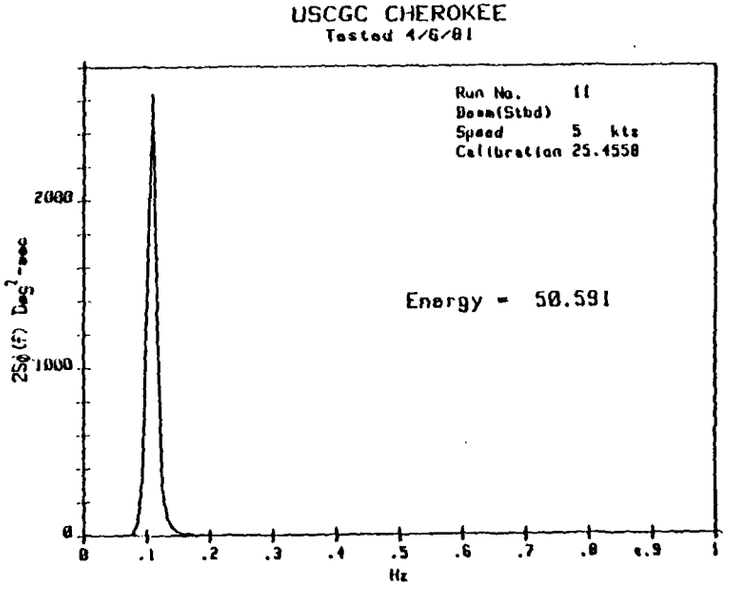
ROLL ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR

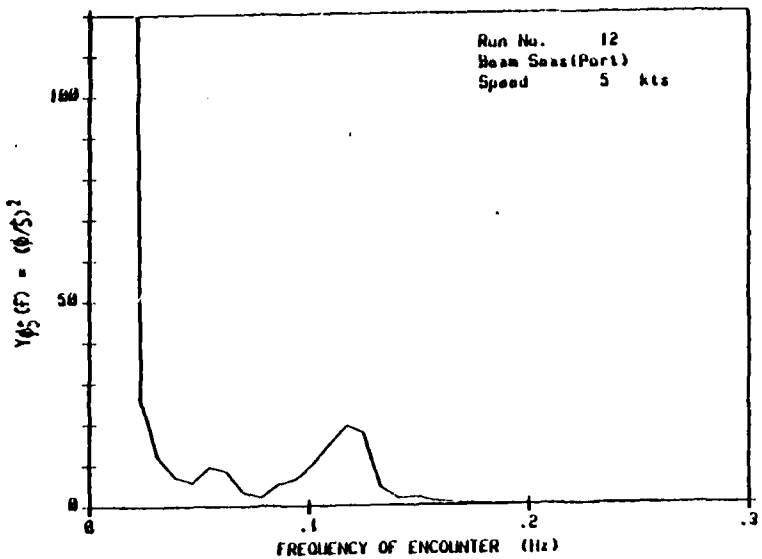


WAVE ENERGY SPECTRUM



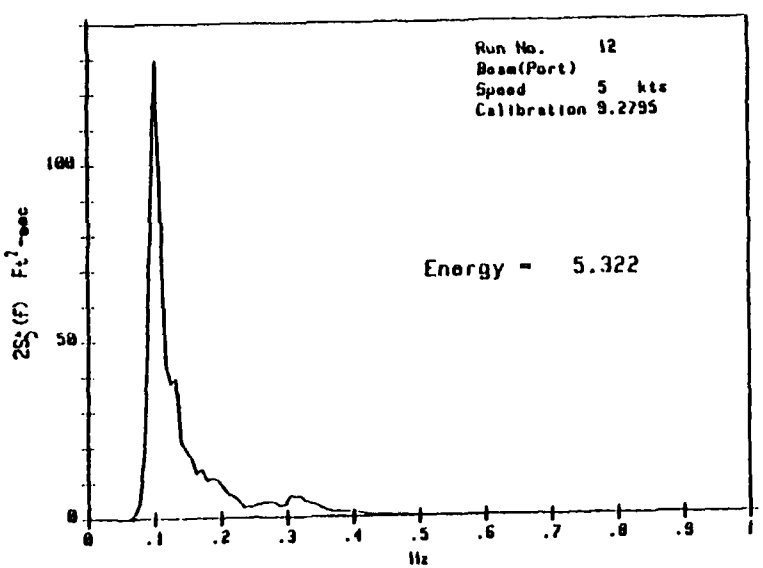
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



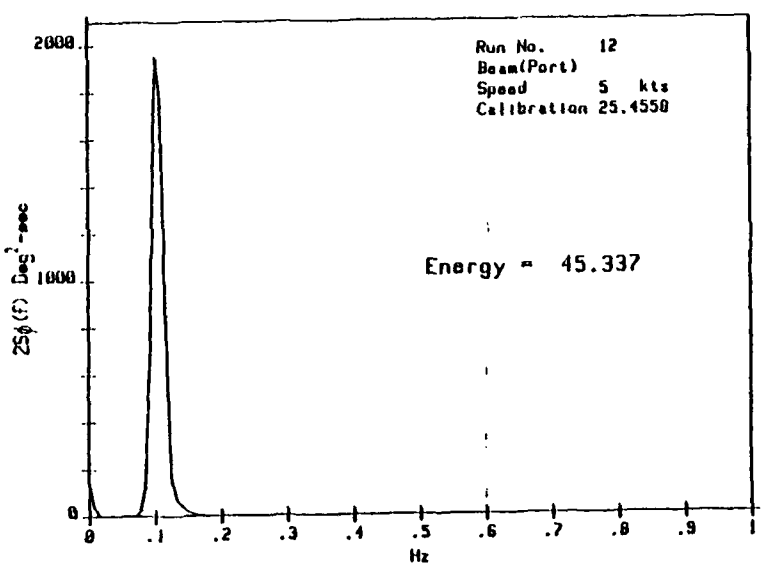
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/6/81



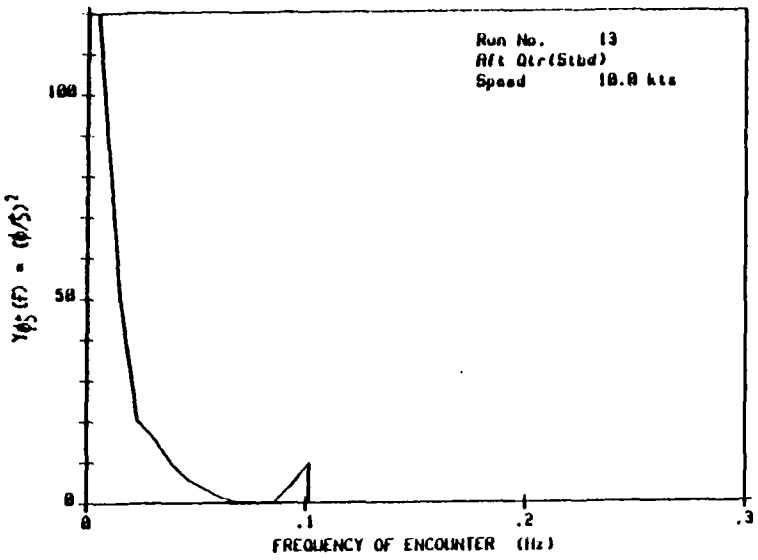
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



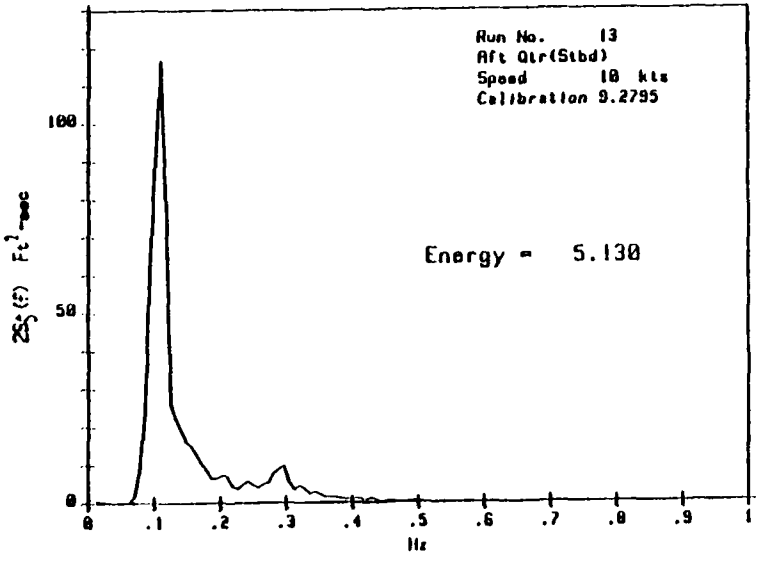
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



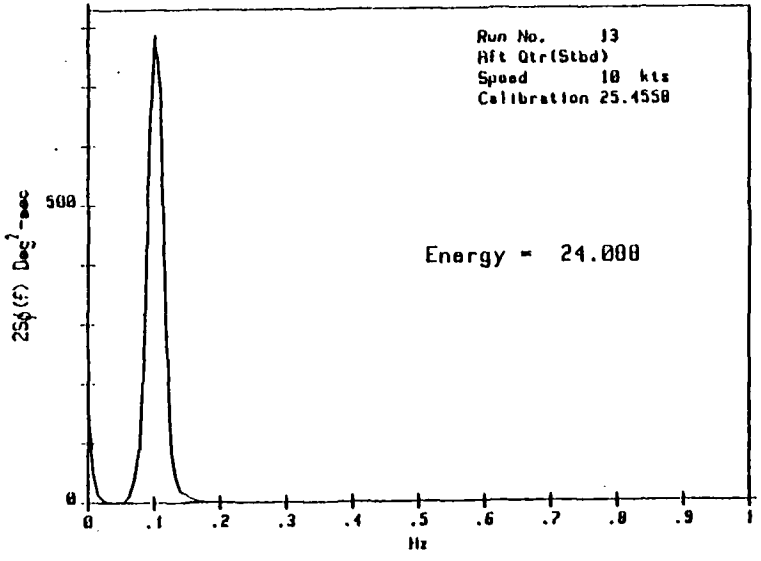
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/6/81



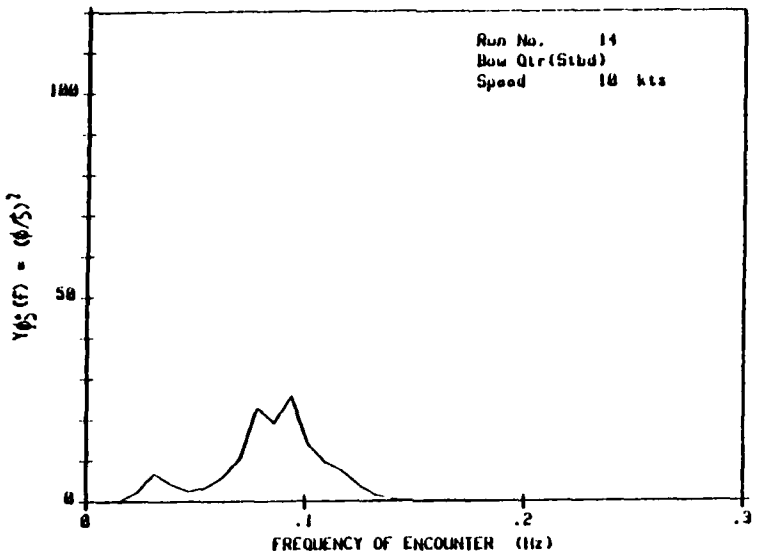
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



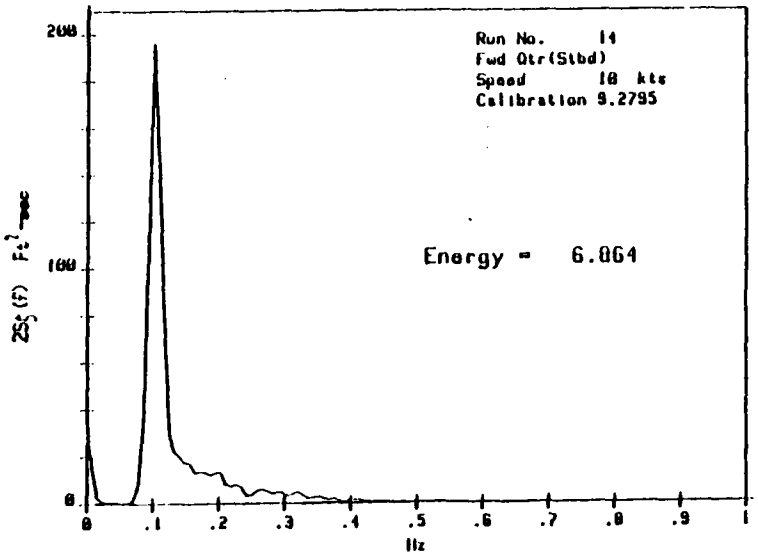
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



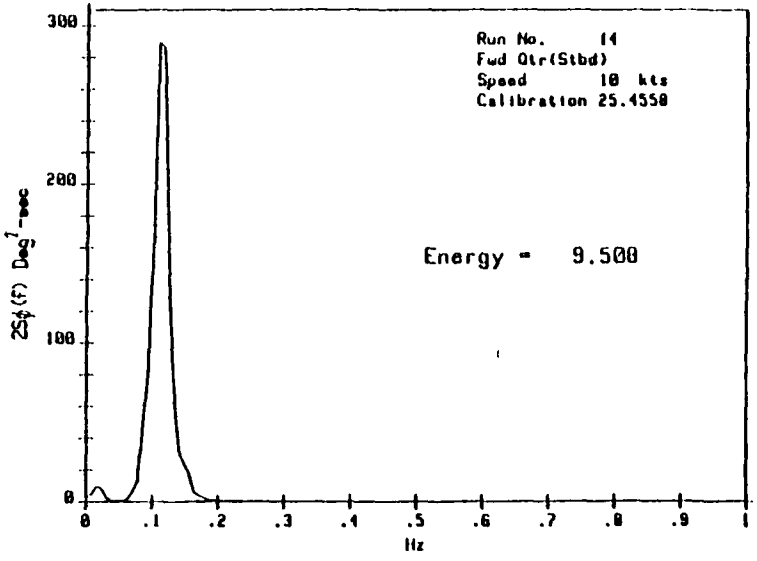
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/6/81



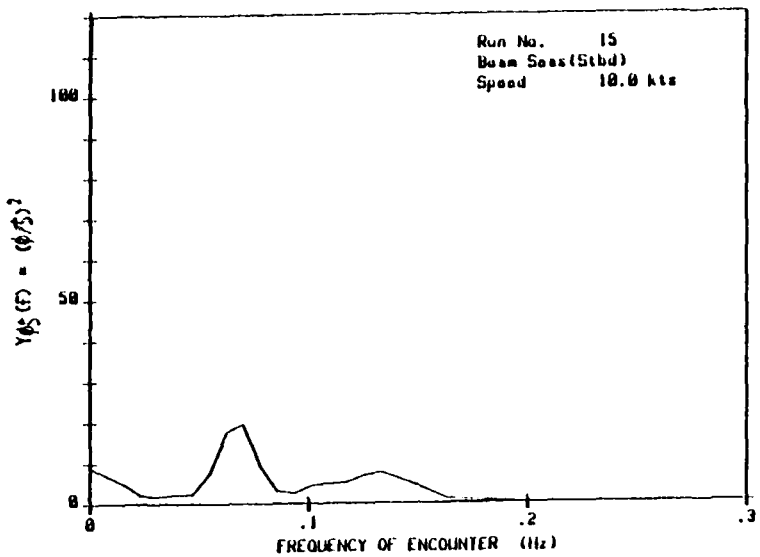
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



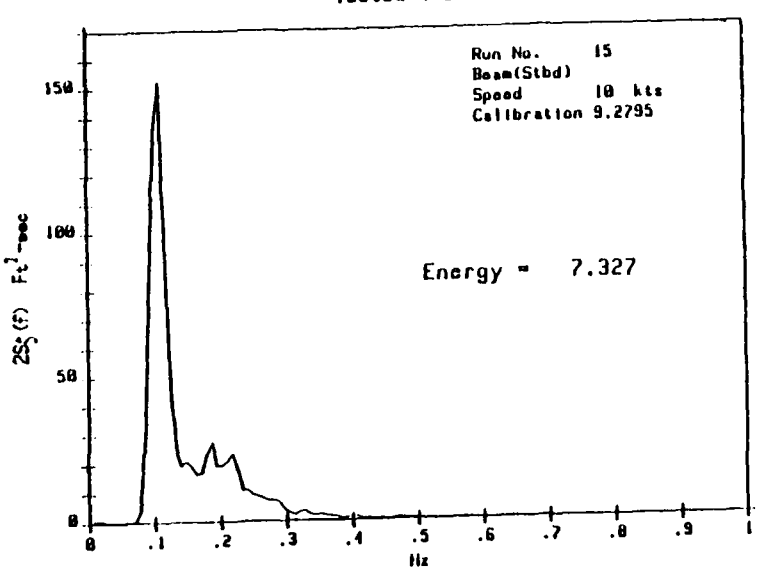
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



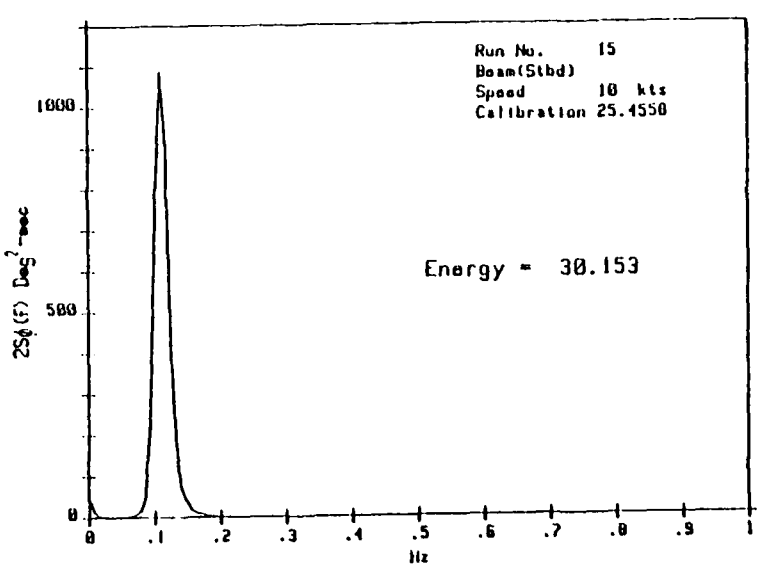
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/6/81



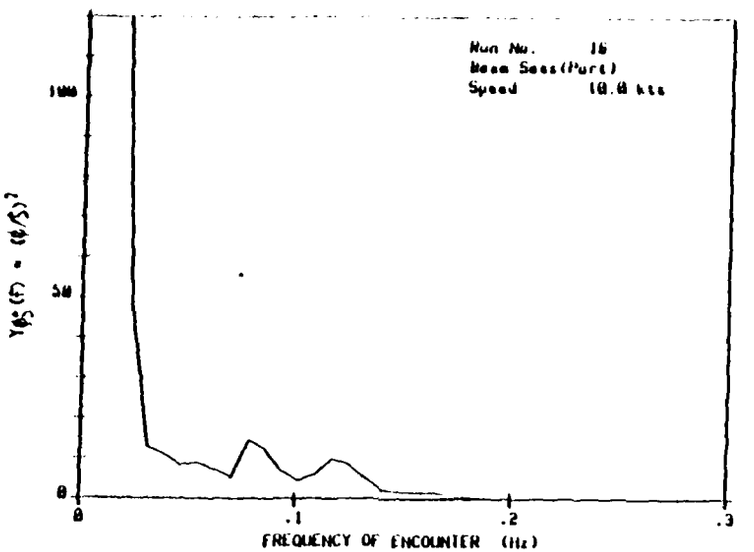
WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



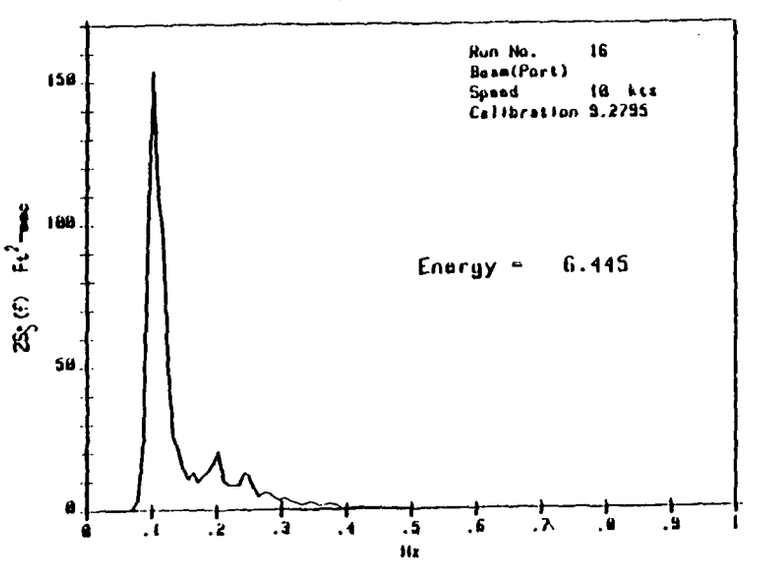
ROLL ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



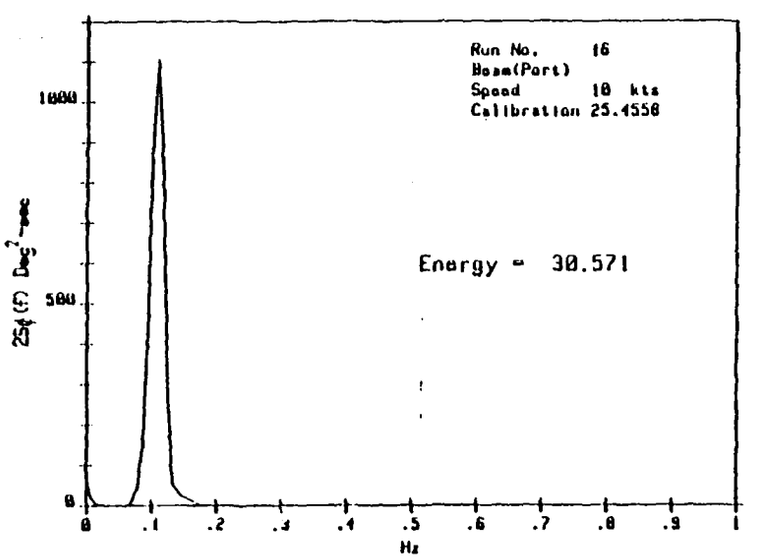
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC CHEROKEE
Tested 4/6/81



WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



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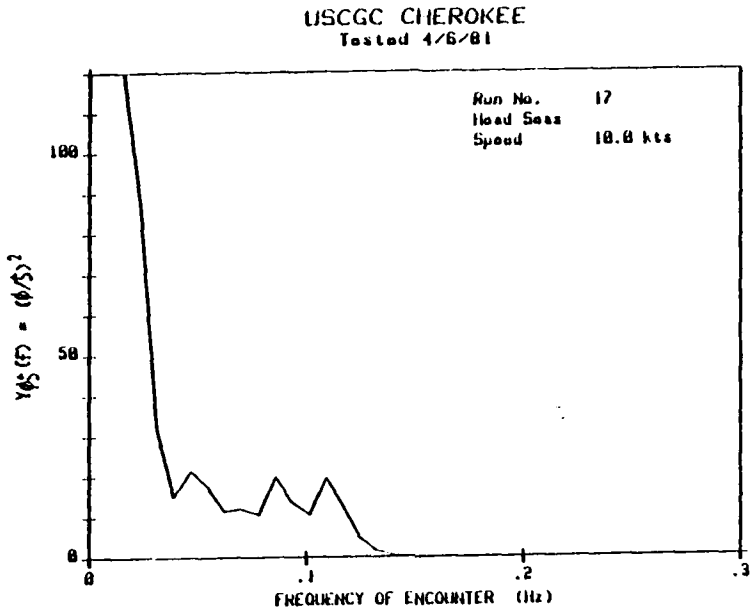

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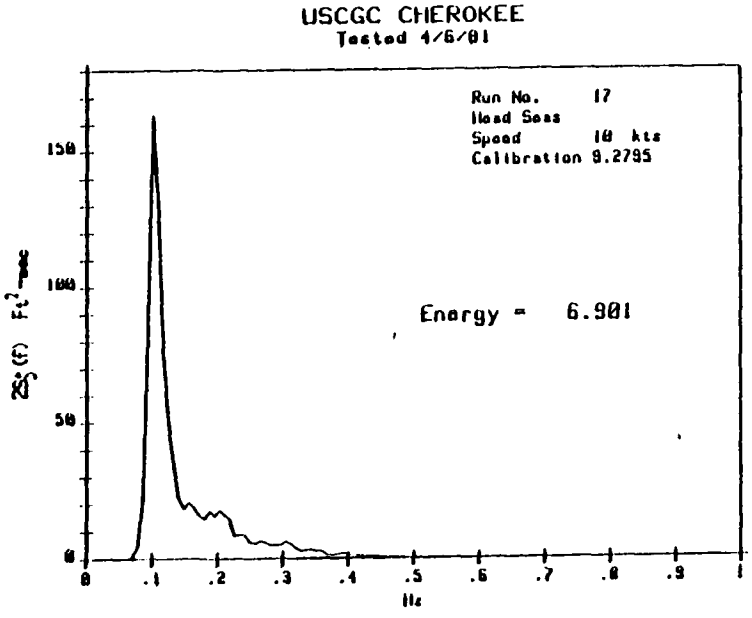

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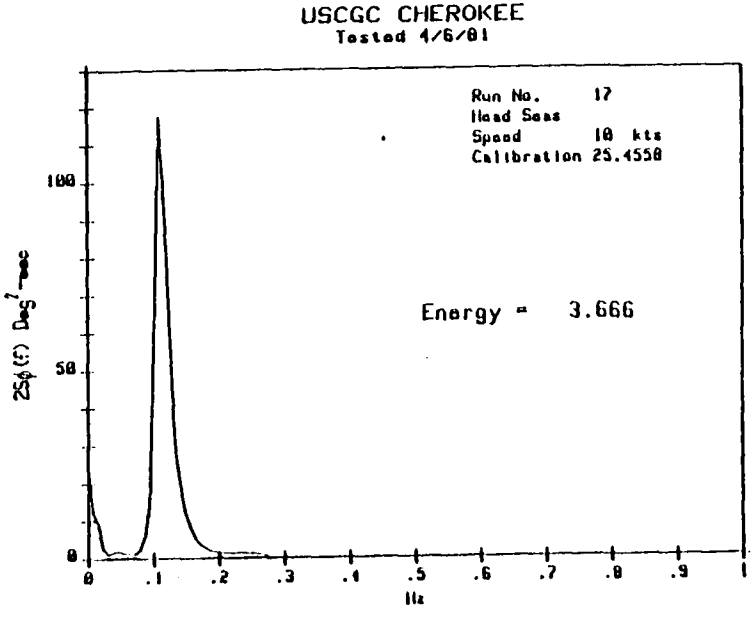

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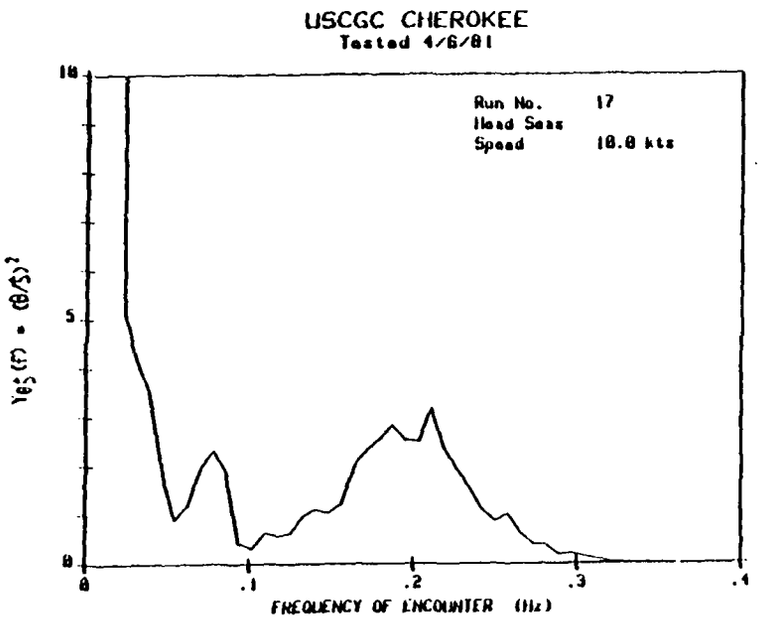
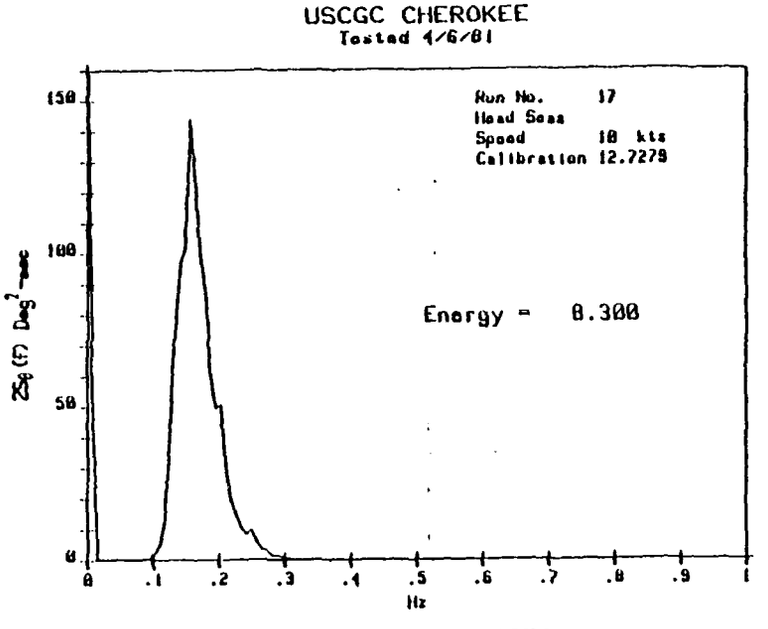
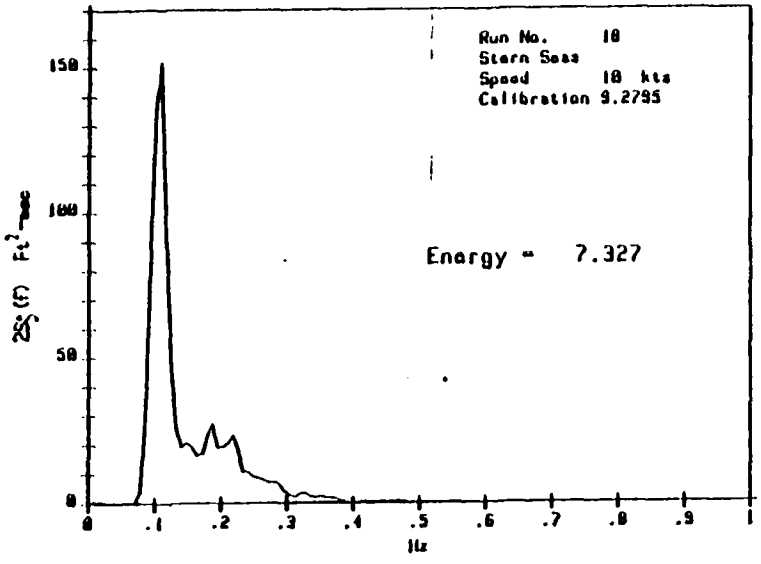


PITCH RESPONSE AMPLITUDE OPERATOR



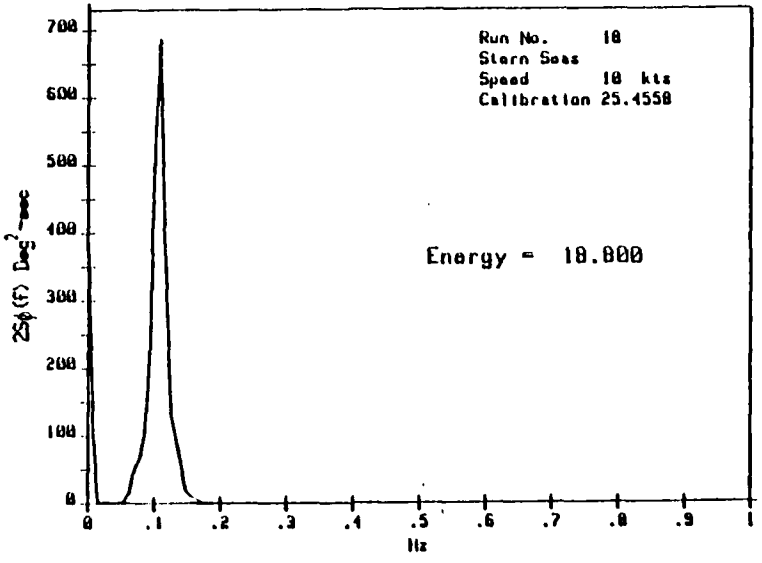
PITCH ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



WAVE ENERGY SPECTRUM

USCGC CHEROKEE
Tested 4/6/81



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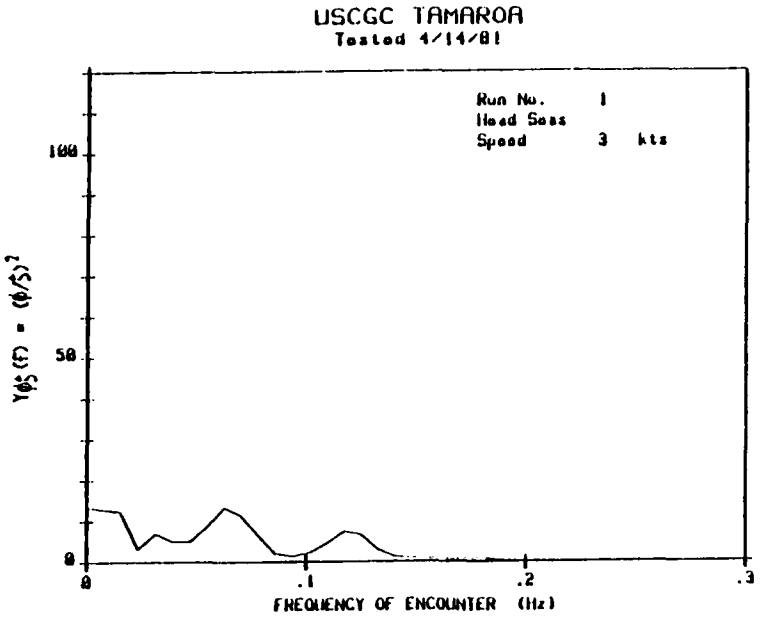
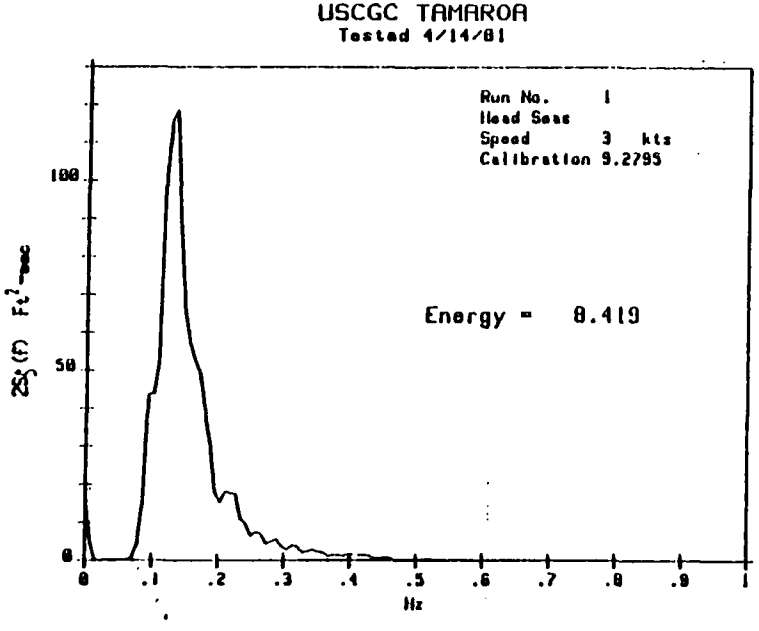


ROLL RESPONSE AMPLITUDE OPERATOR



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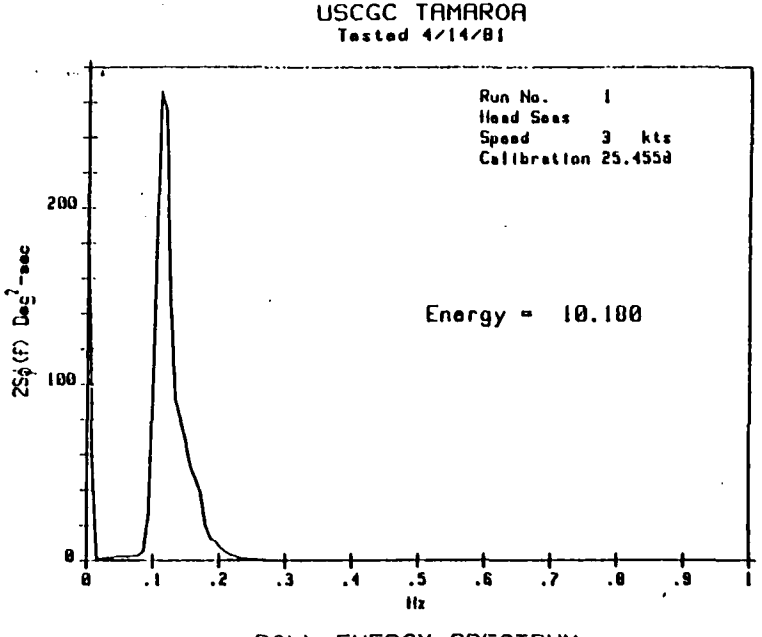
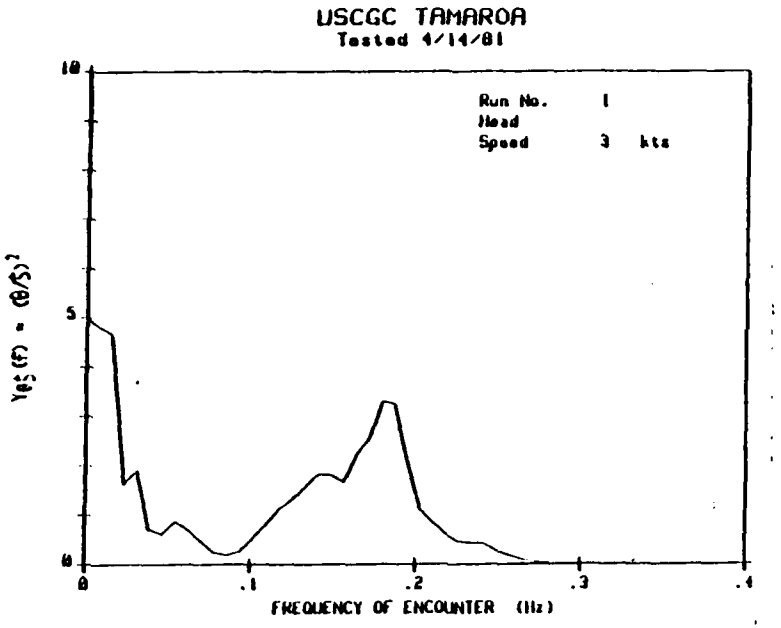
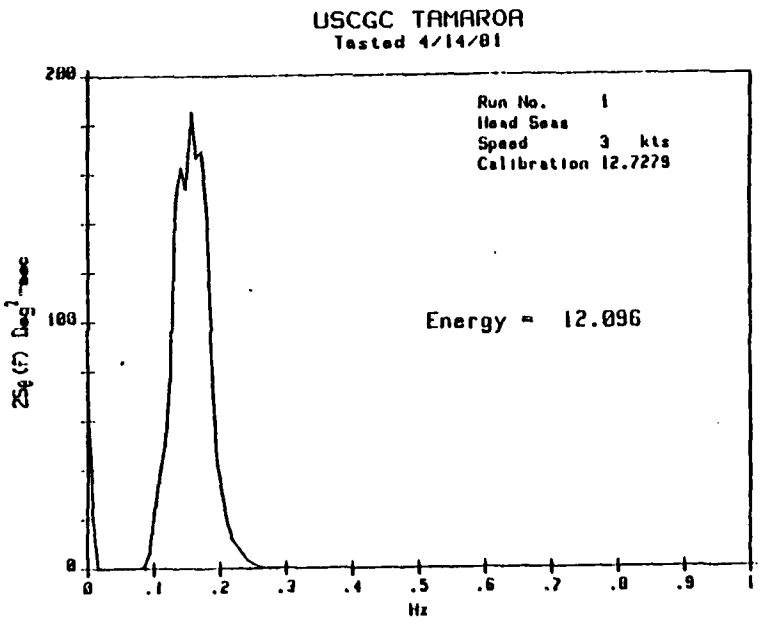


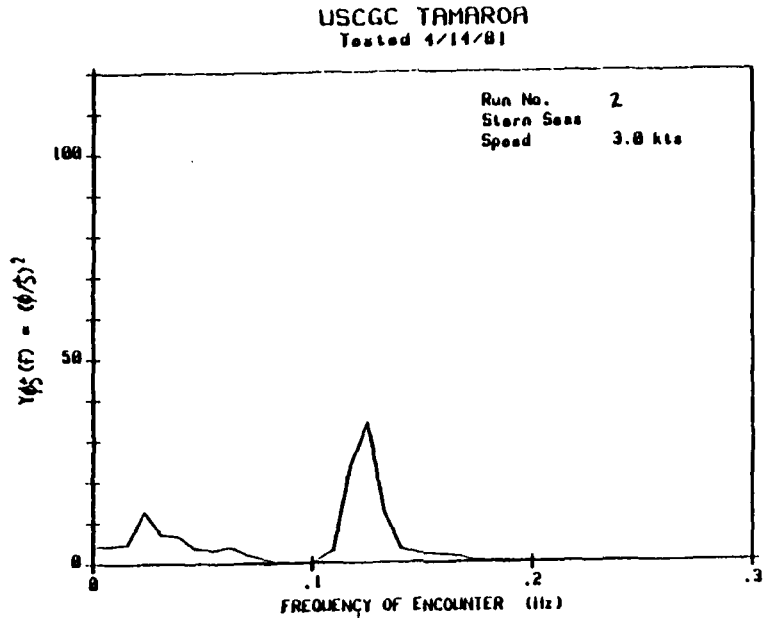
ROLL ENERGY SPECTRUM



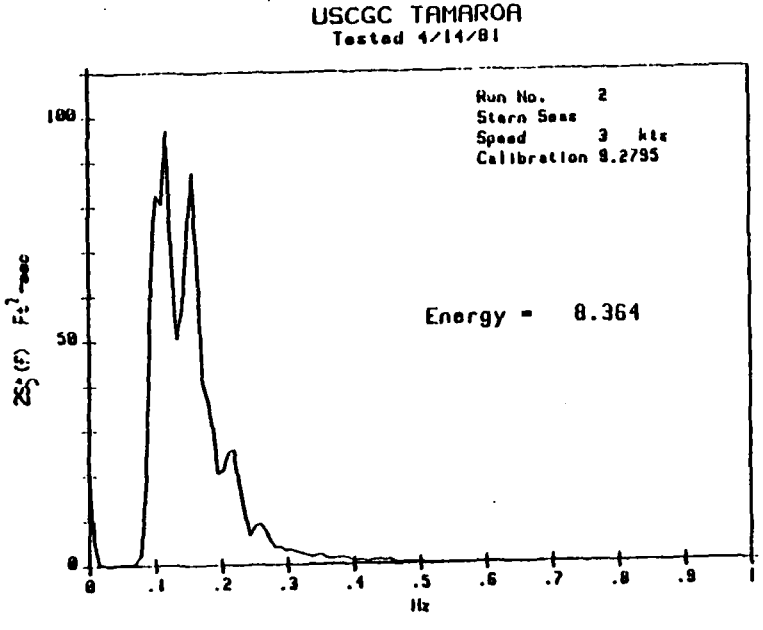
PITCH RESPONSE AMPLITUDE OPERATOR



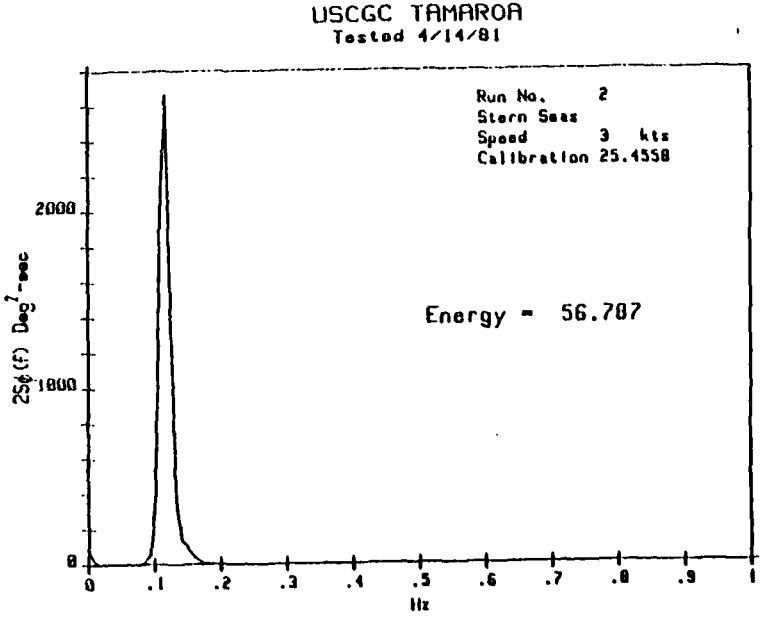
PITCH ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR

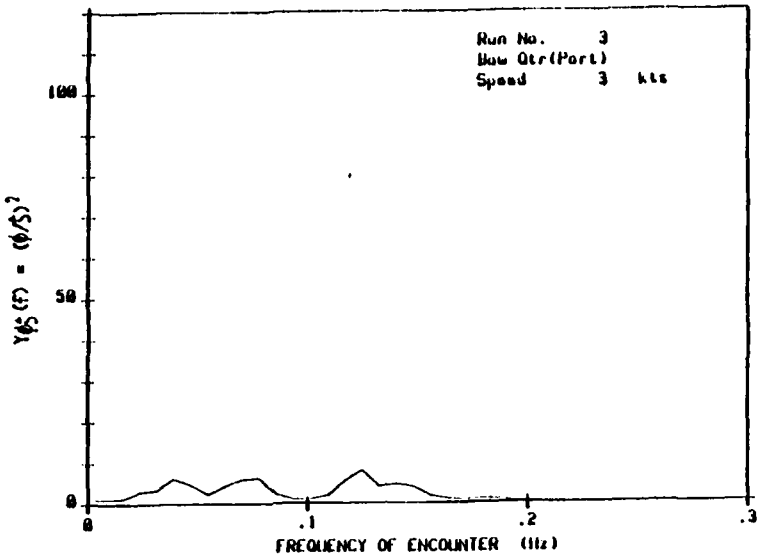


WAVE ENERGY SPECTRUM



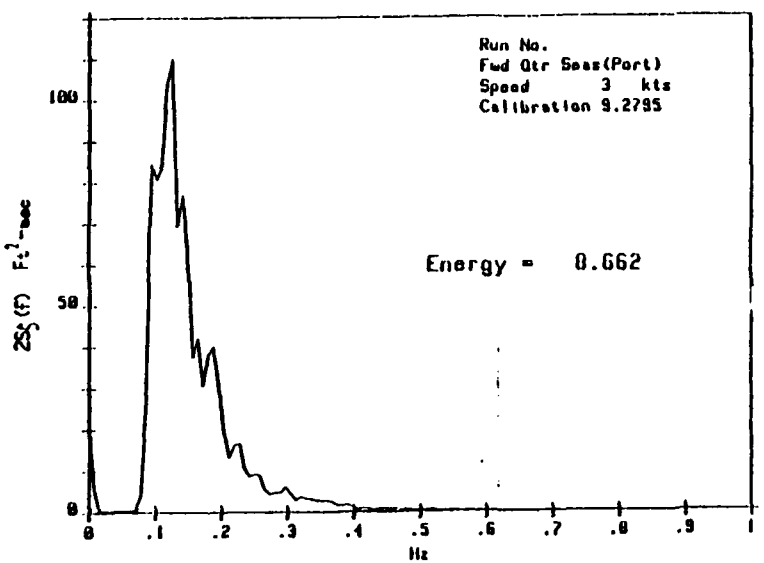
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



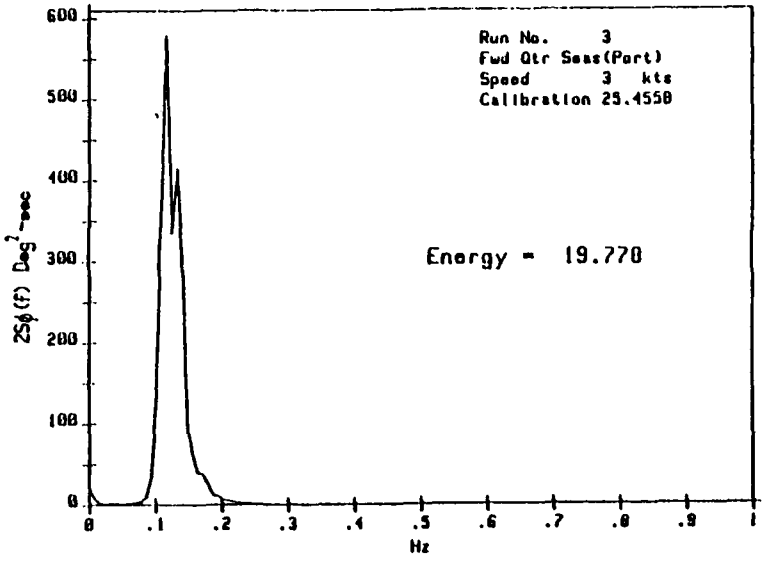
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81

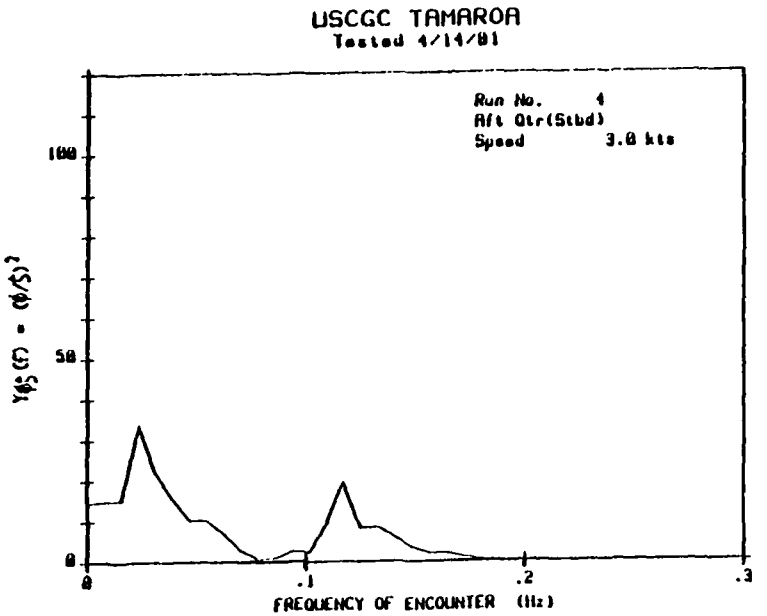


WAVE ENERGY SPECTRUM

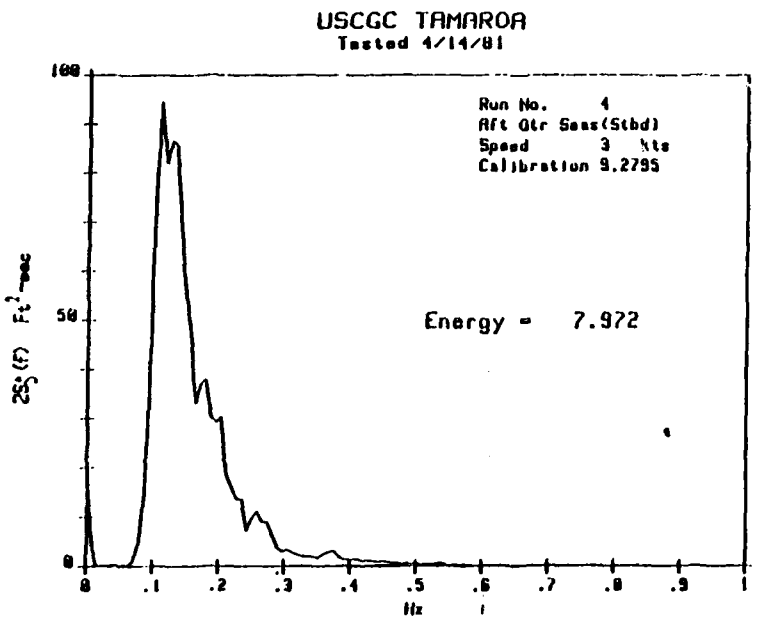
USCGC TAMAROA
Tested 4/14/81



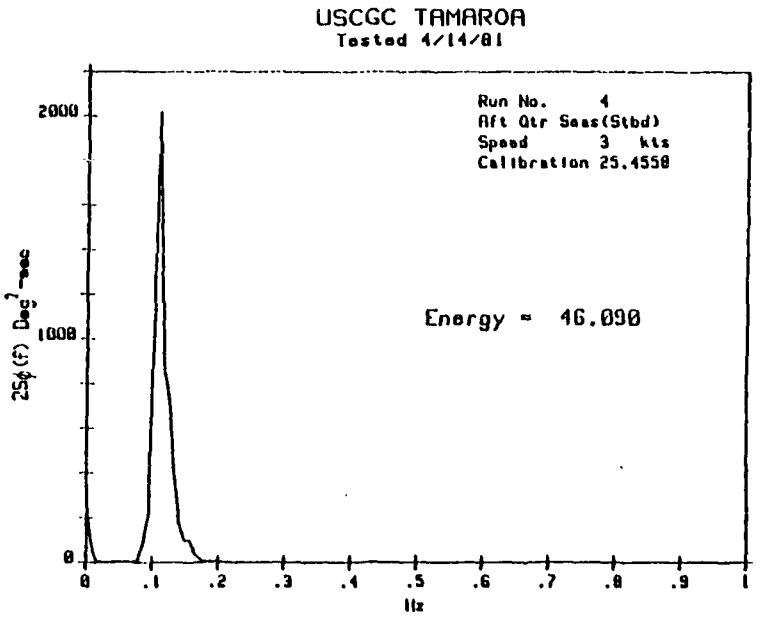
ROLL ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR

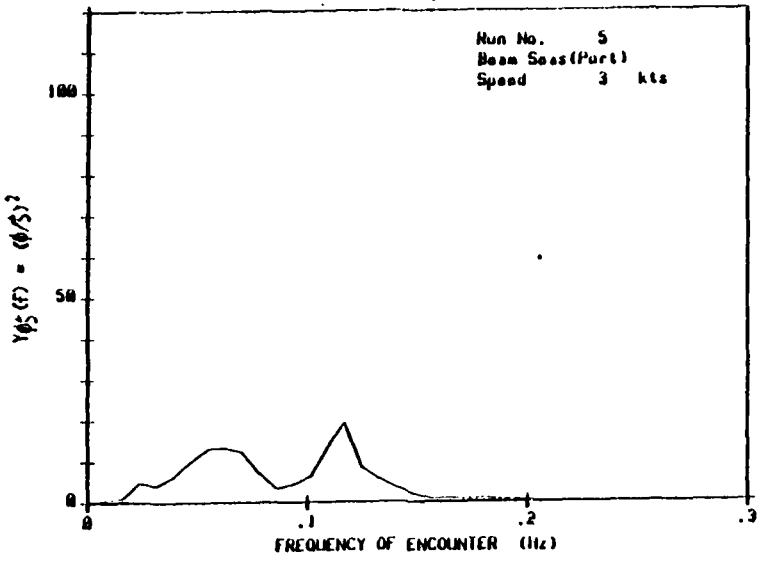


WAVE ENERGY SPECTRUM



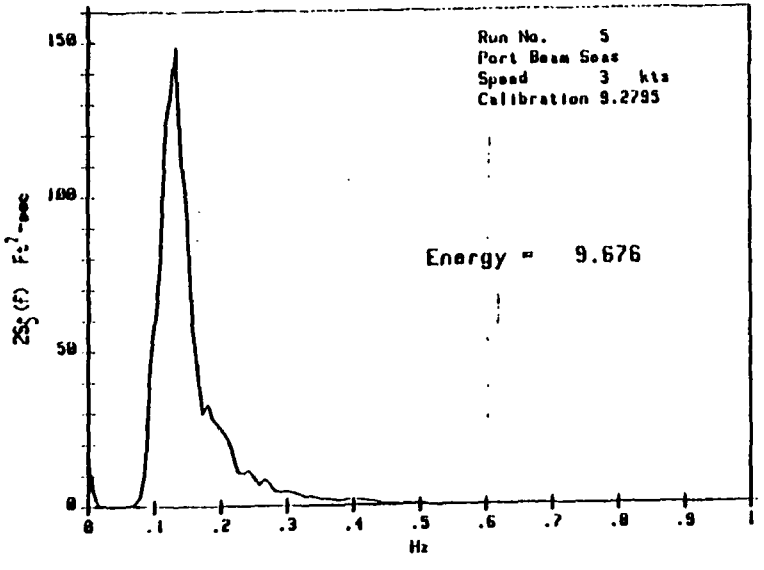
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



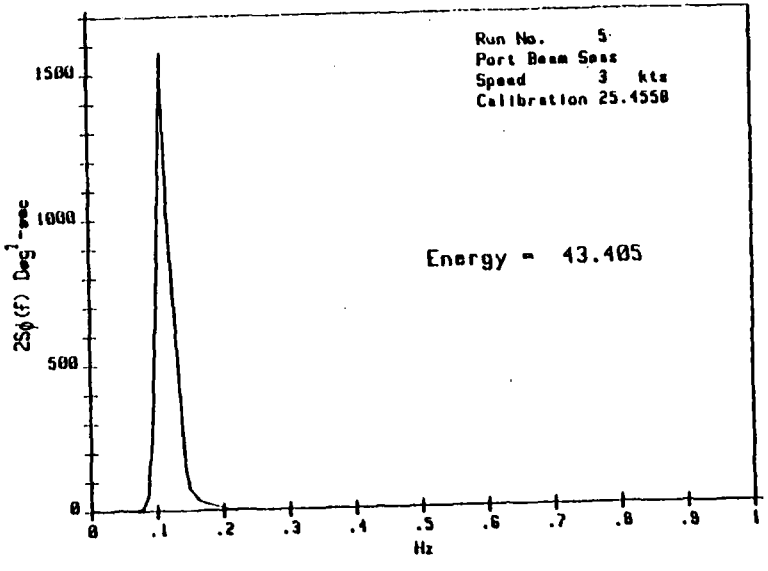
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81



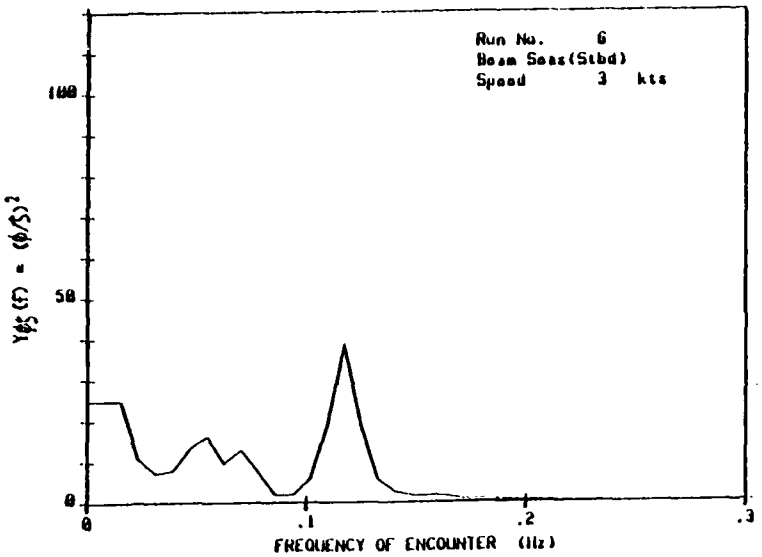
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



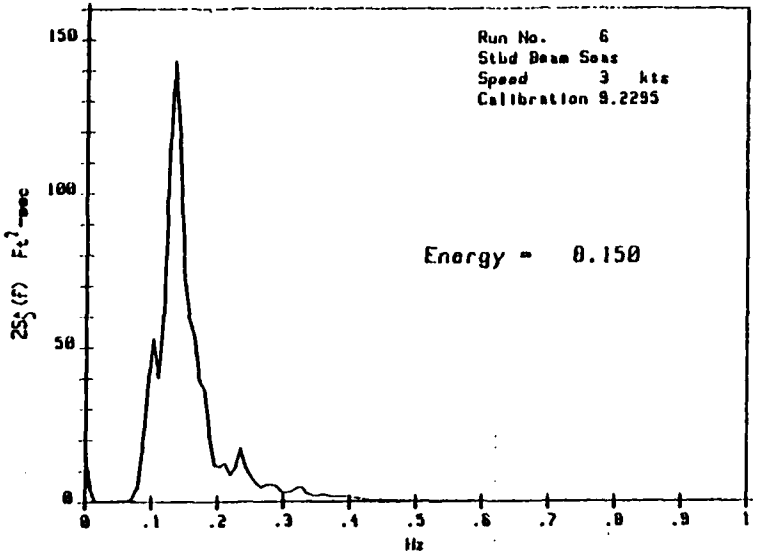
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



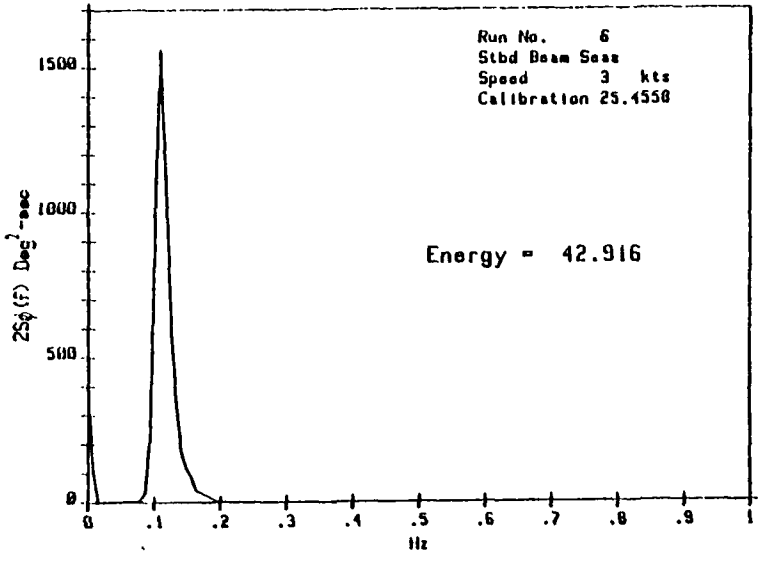
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81



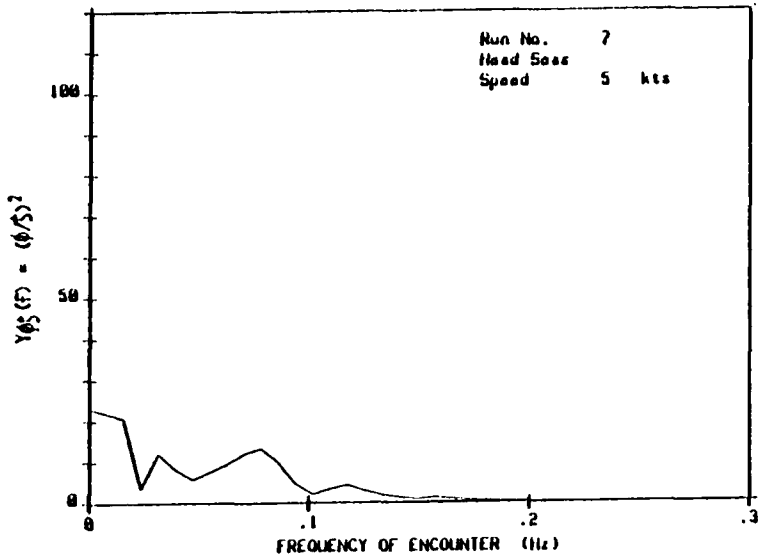
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



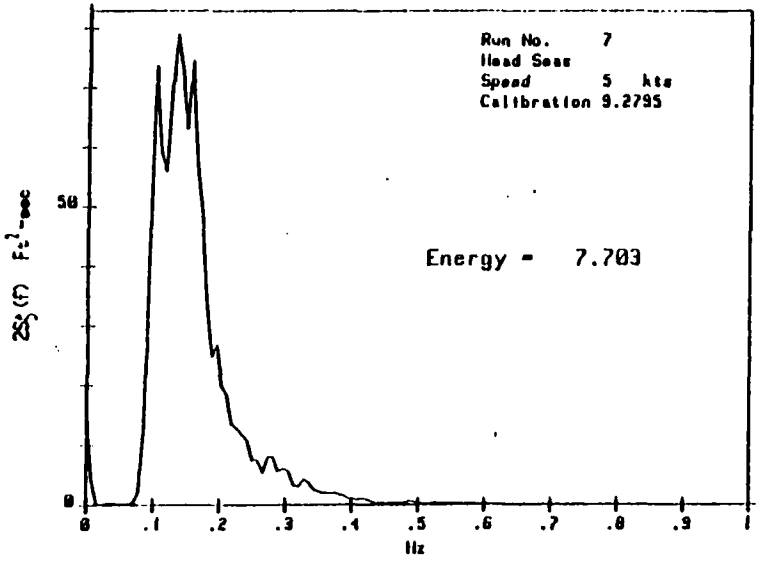
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



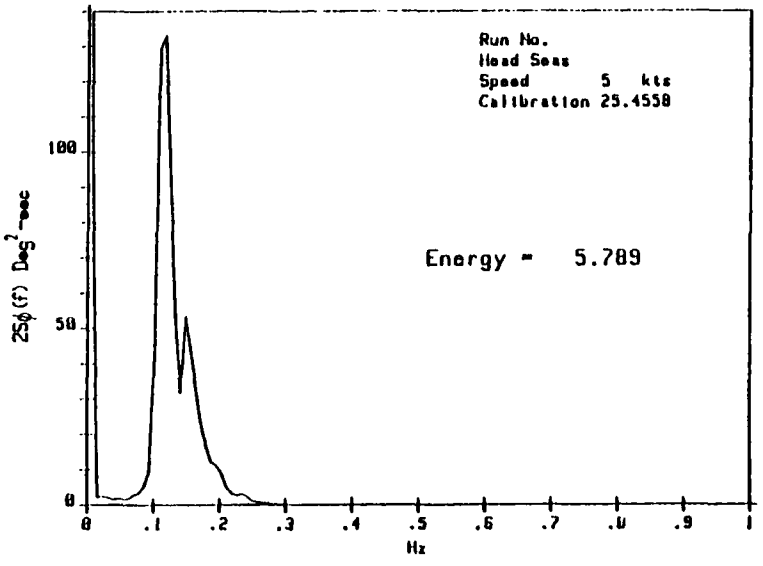
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81

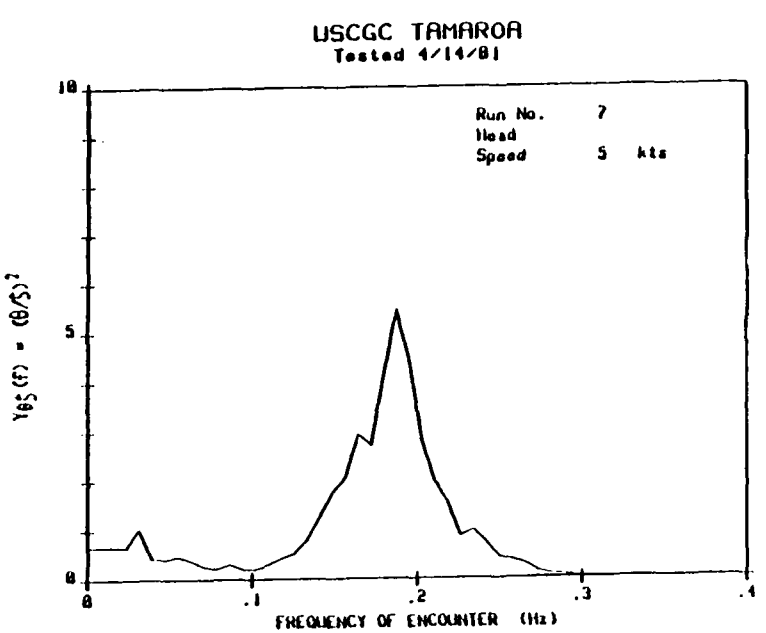


WAVE ENERGY SPECTRUM

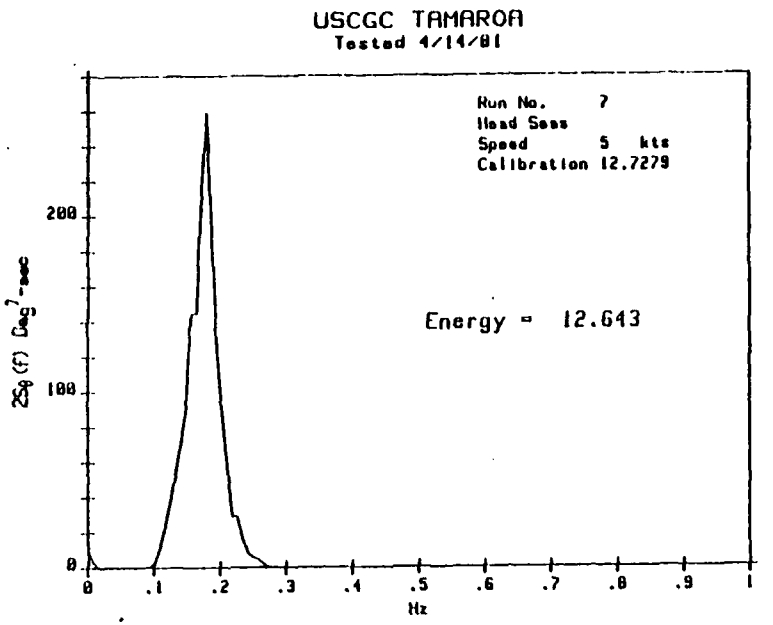
USCGC TAMAROA
Tested 4/14/81



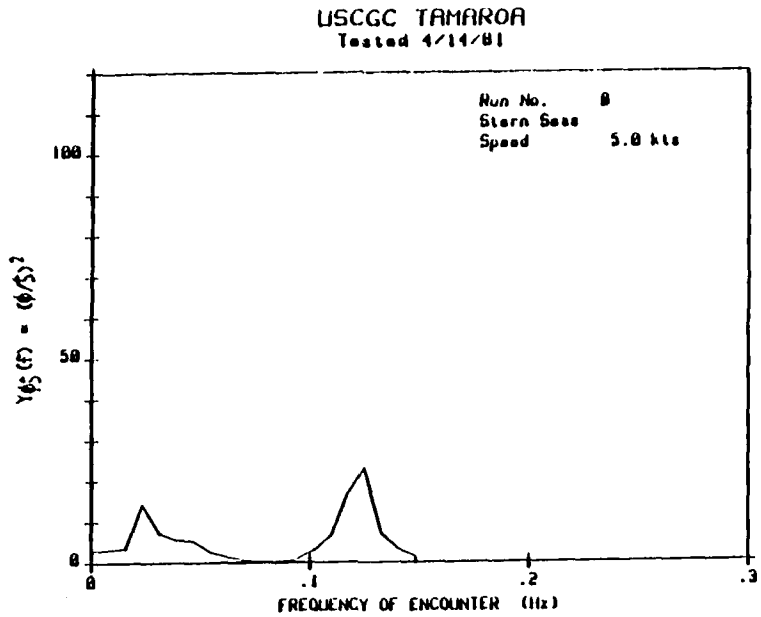
ROLL ENERGY SPECTRUM



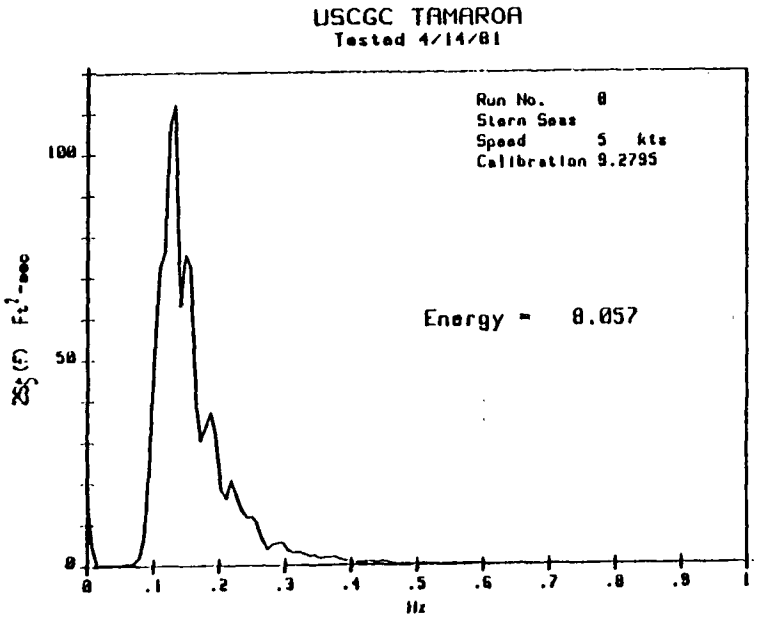
PITCH RESPONSE AMPLITUDE OPERATOR



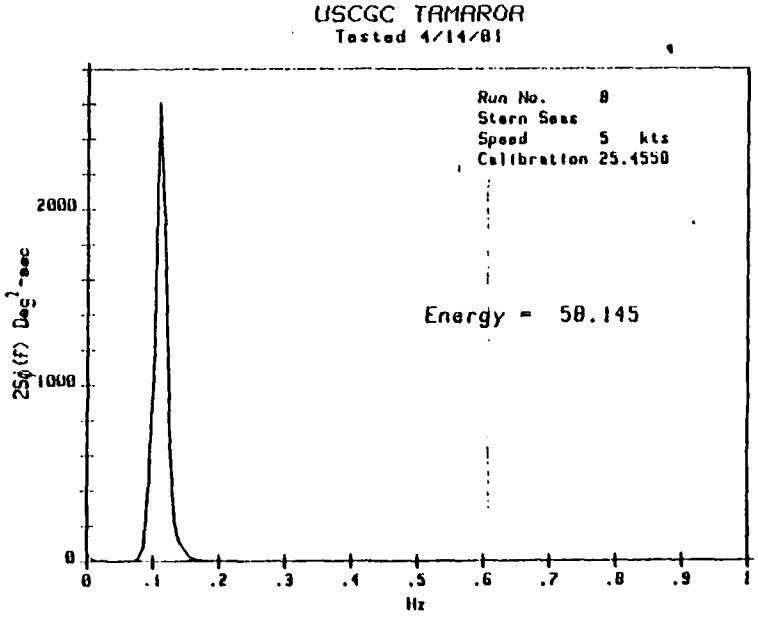
PITCH ENERGY SPECTRUM



ROLL RESPONSE AMPLITUDE OPERATOR

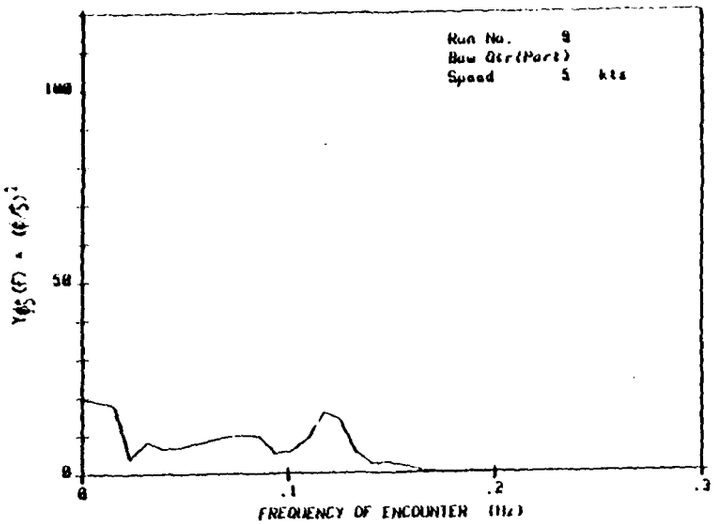


WAVE ENERGY SPECTRUM



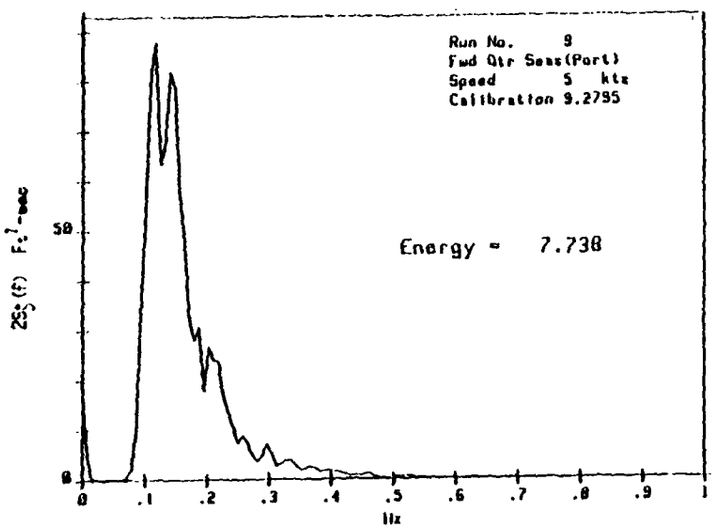
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



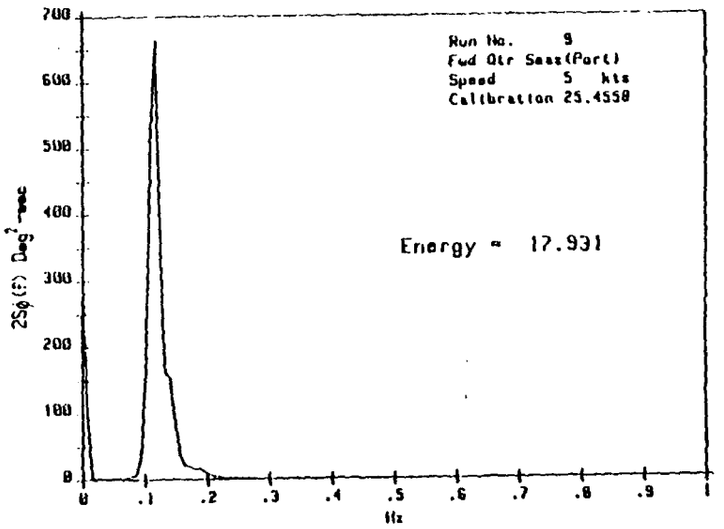
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81



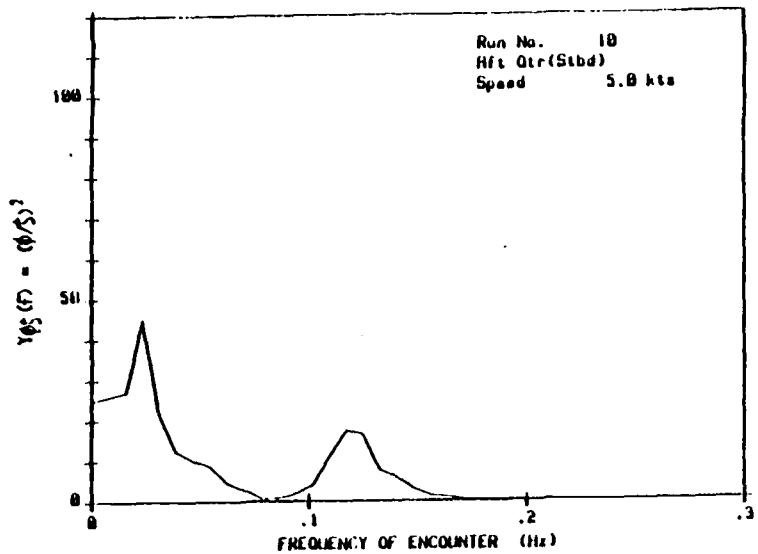
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



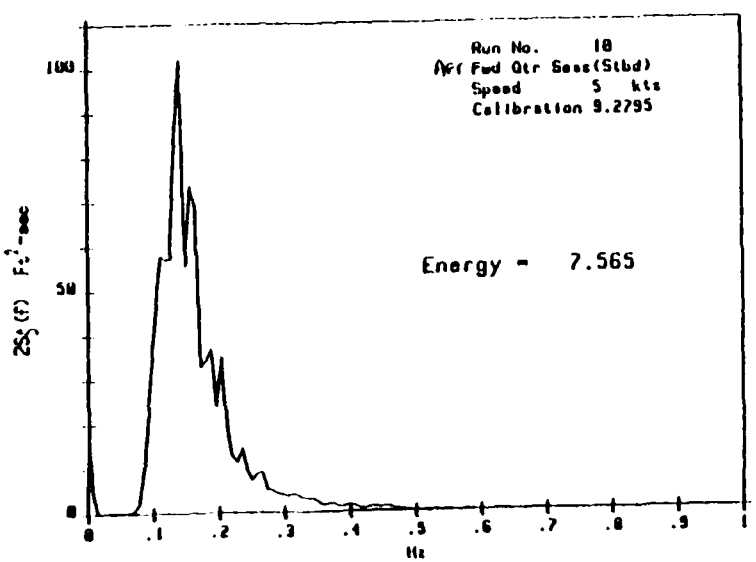
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



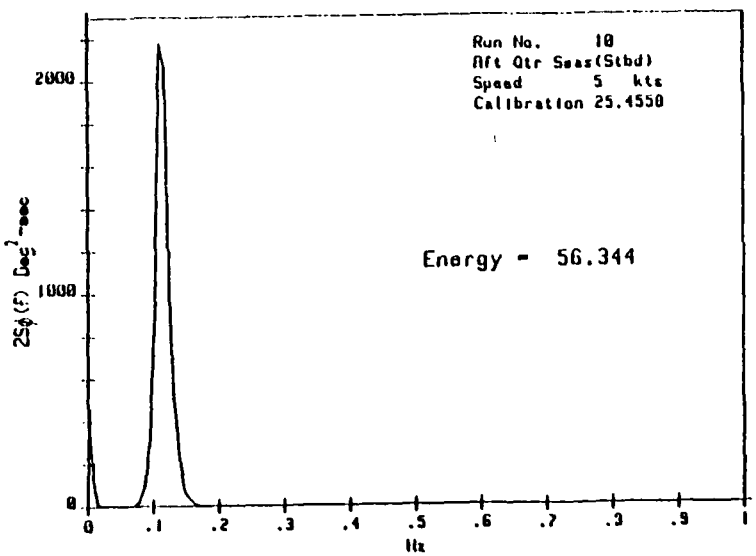
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81



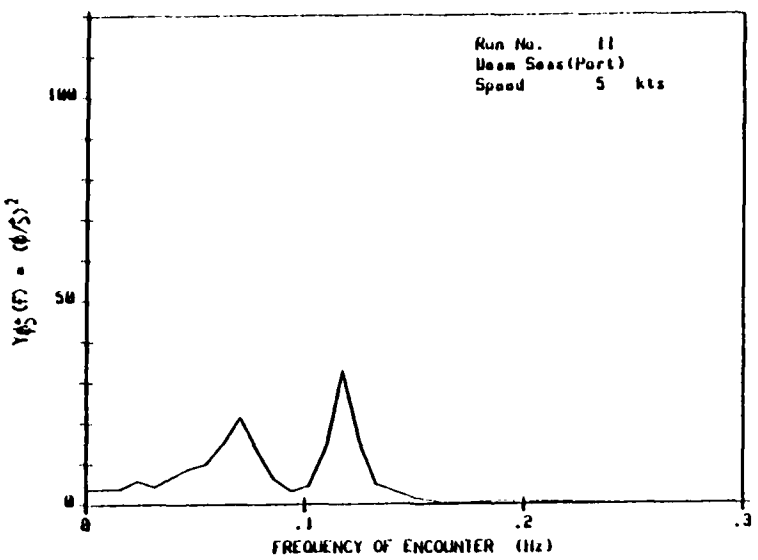
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



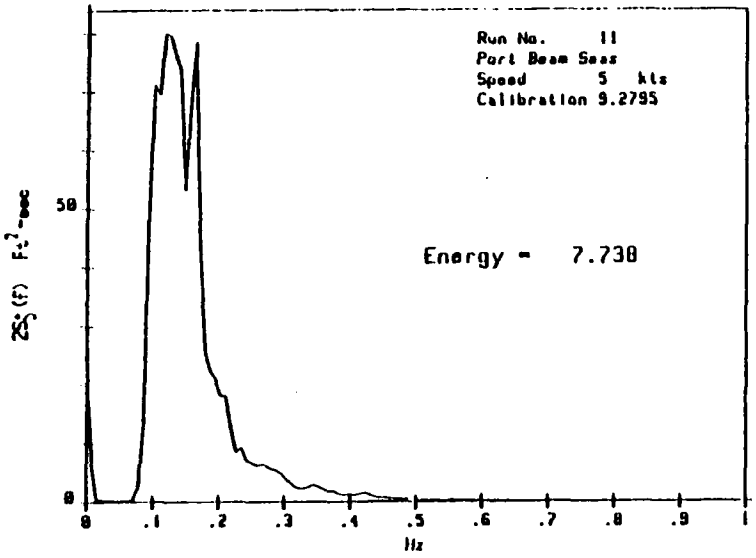
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



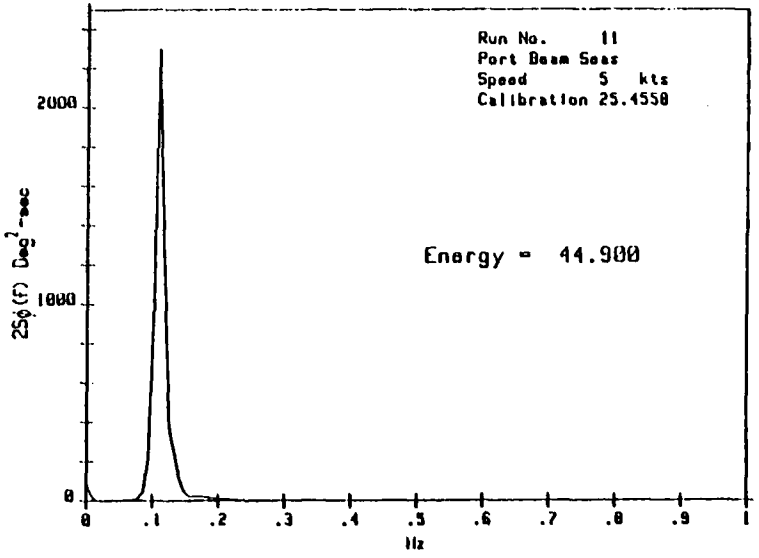
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81



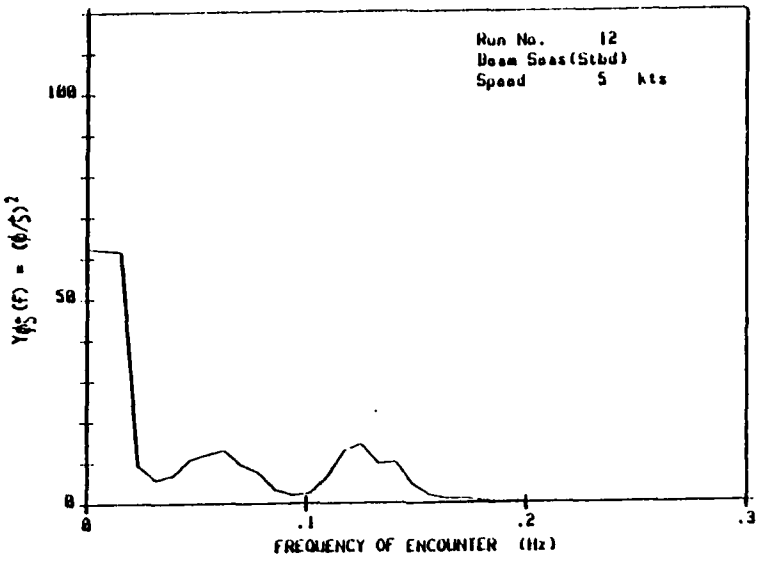
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



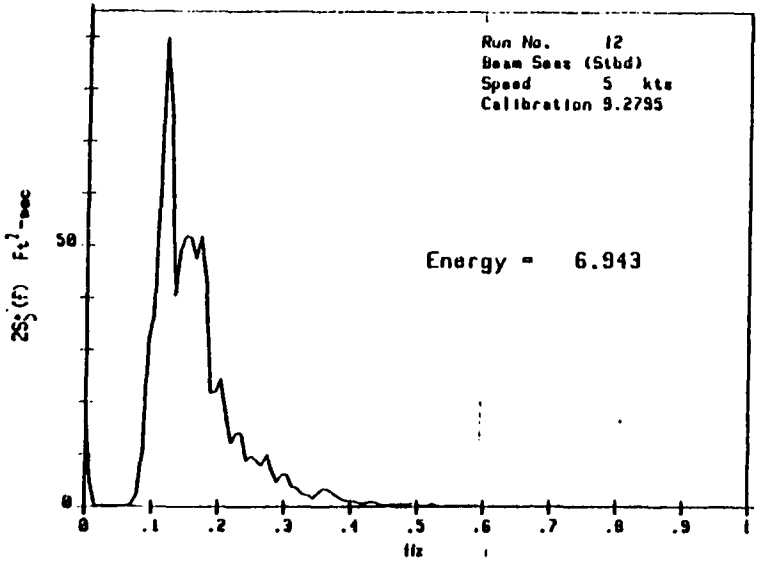
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



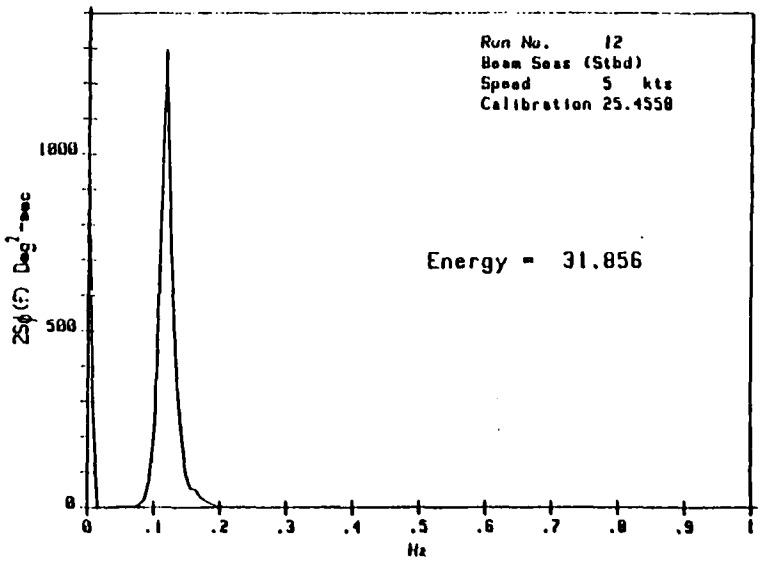
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81



WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



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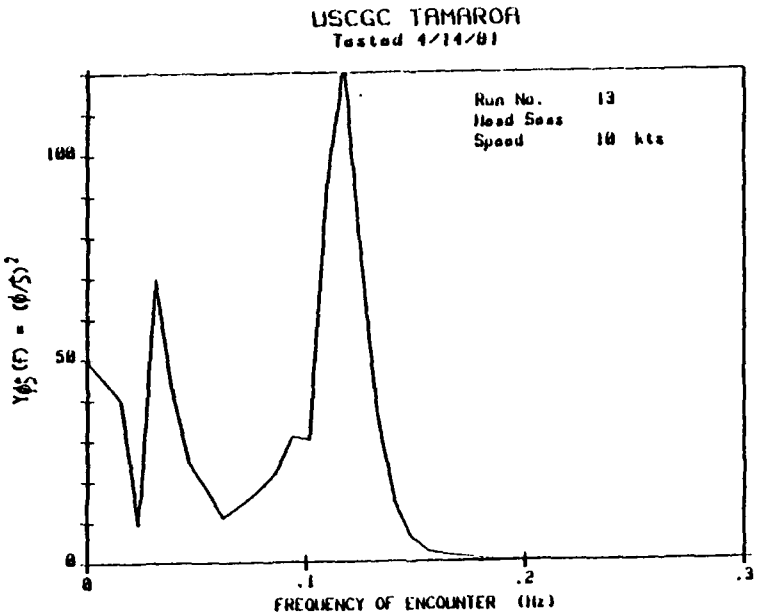
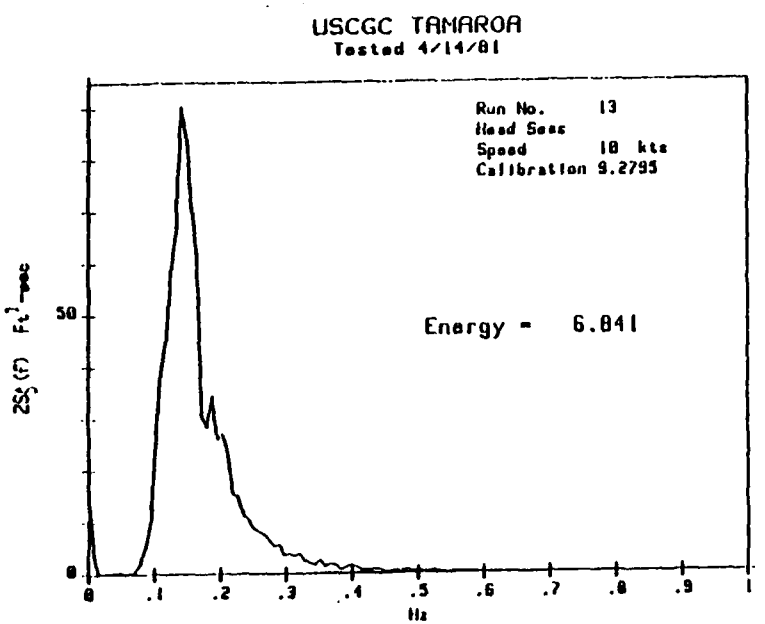


ROLL RESPONSE AMPLITUDE OPERATOR



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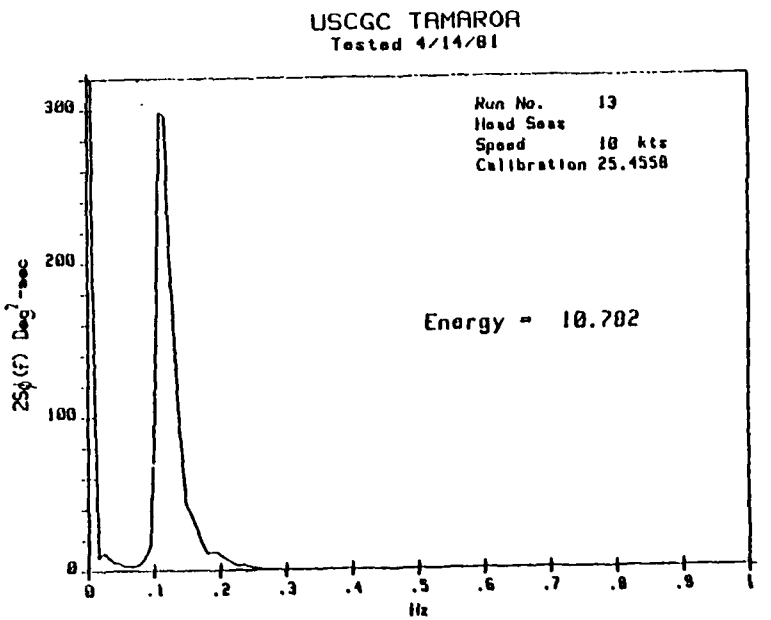
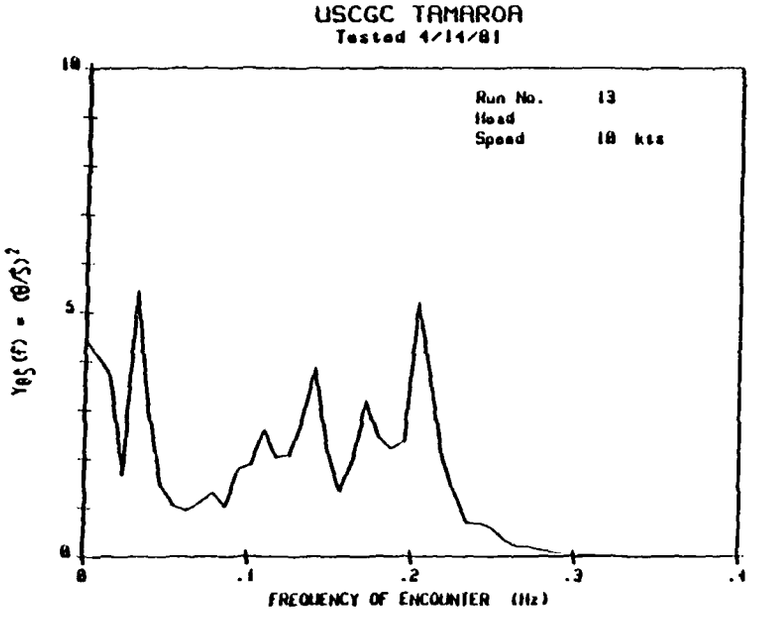
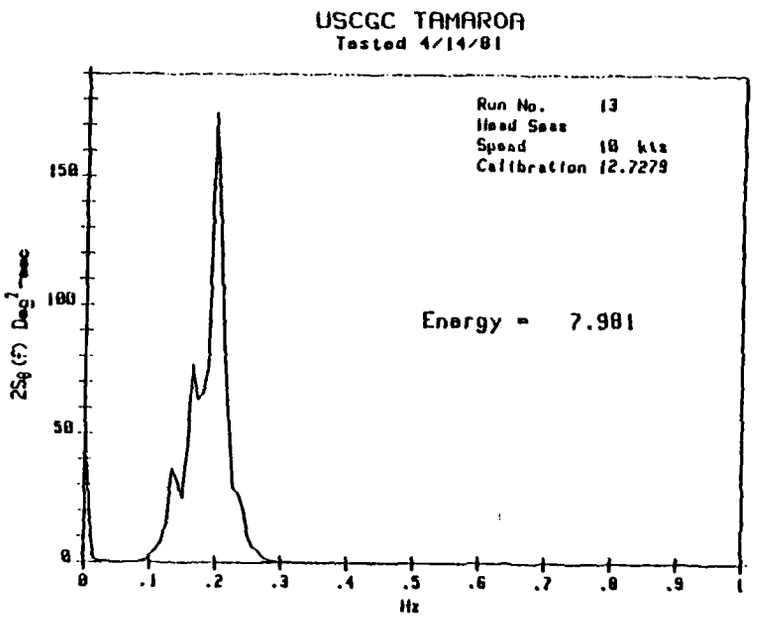


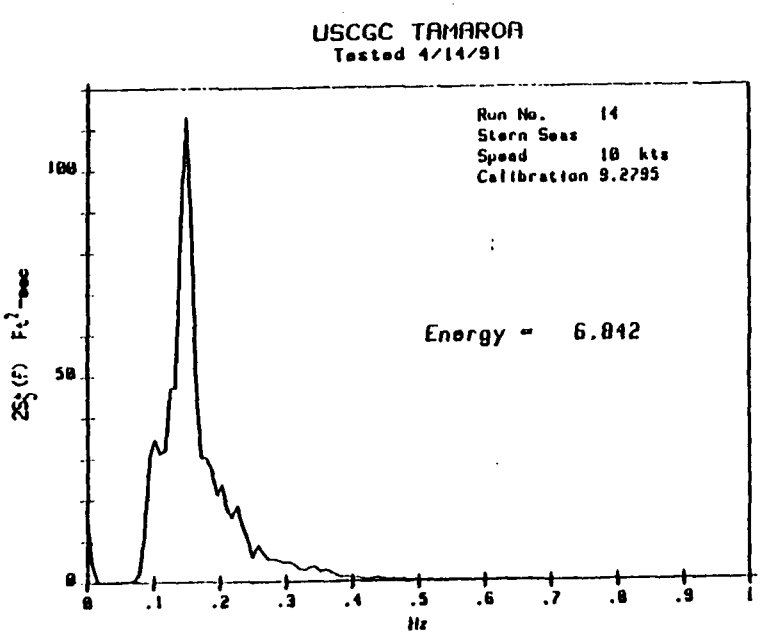
ROLL ENERGY SPECTRUM



PITCH RESPONSE AMPLITUDE OPERATOR



PITCH ENERGY SPECTRUM



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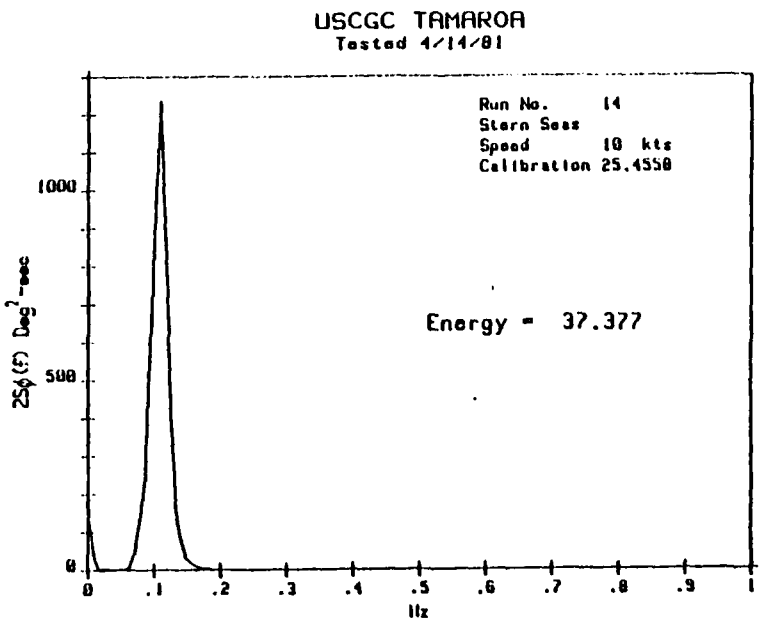
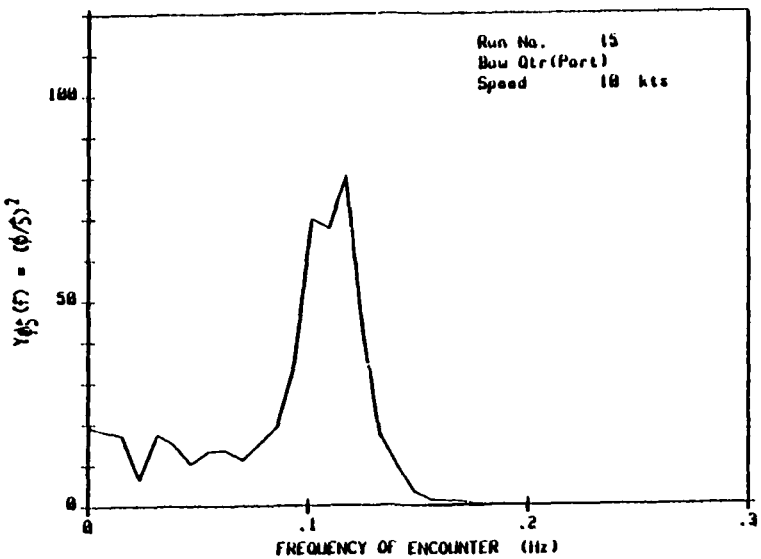


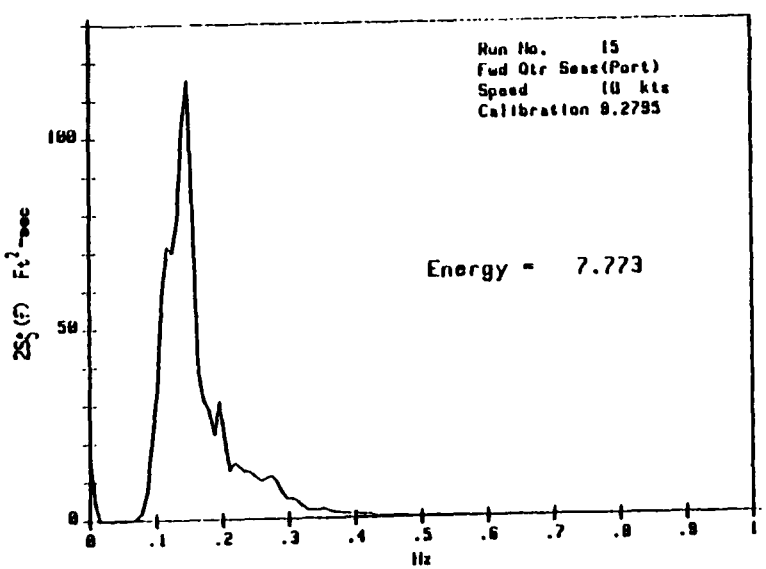
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



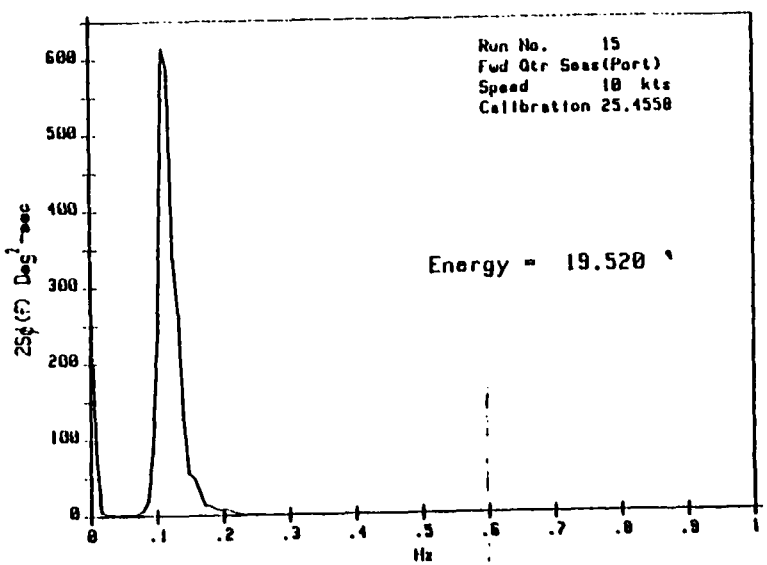
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81



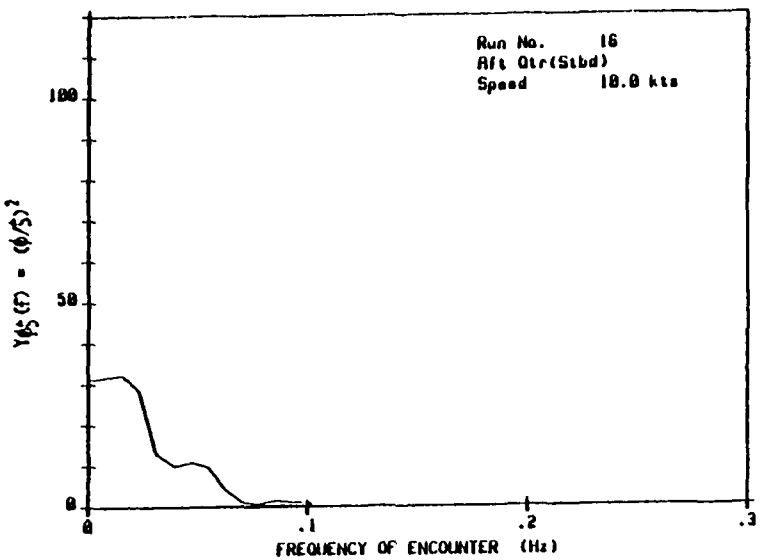
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



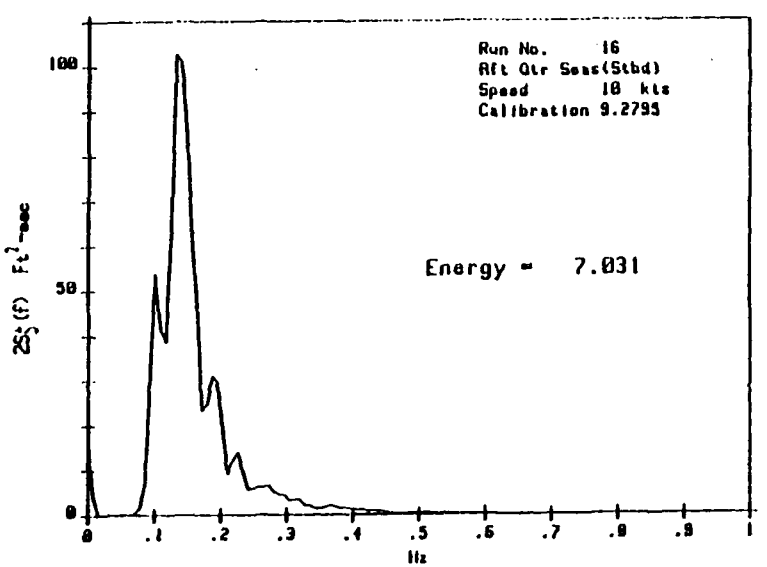
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



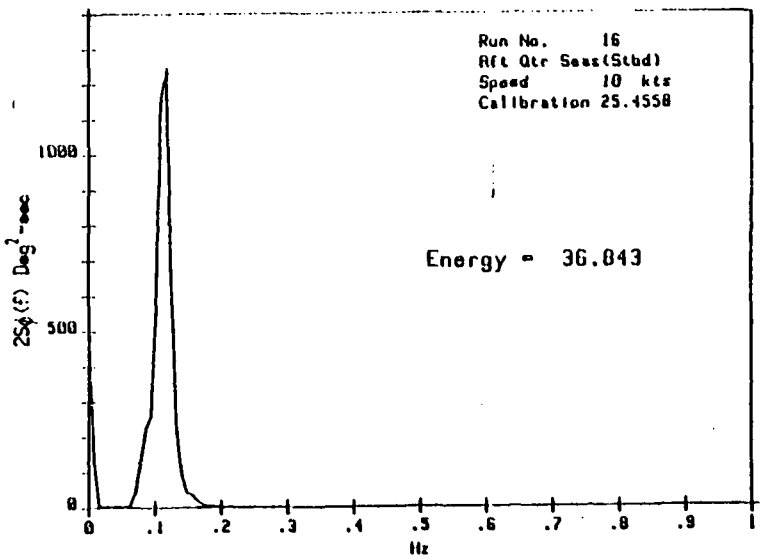
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/14/81



WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/14/81



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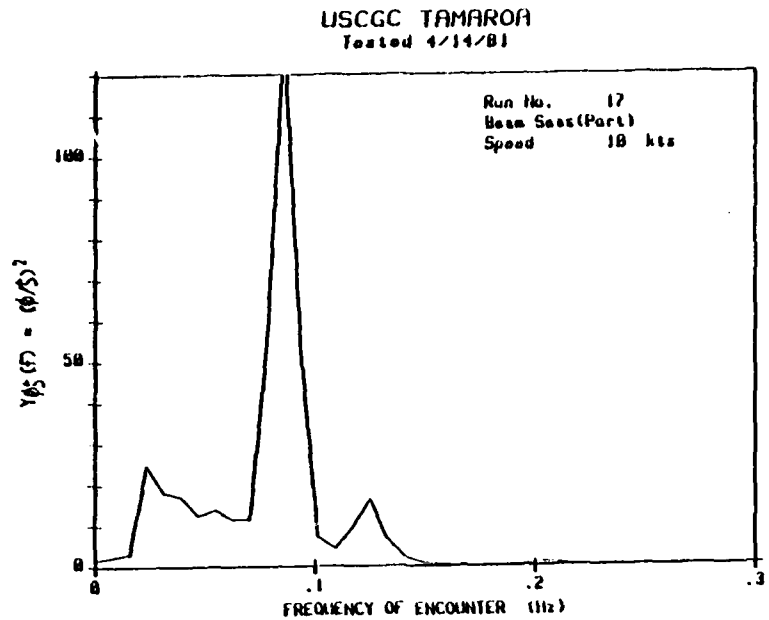
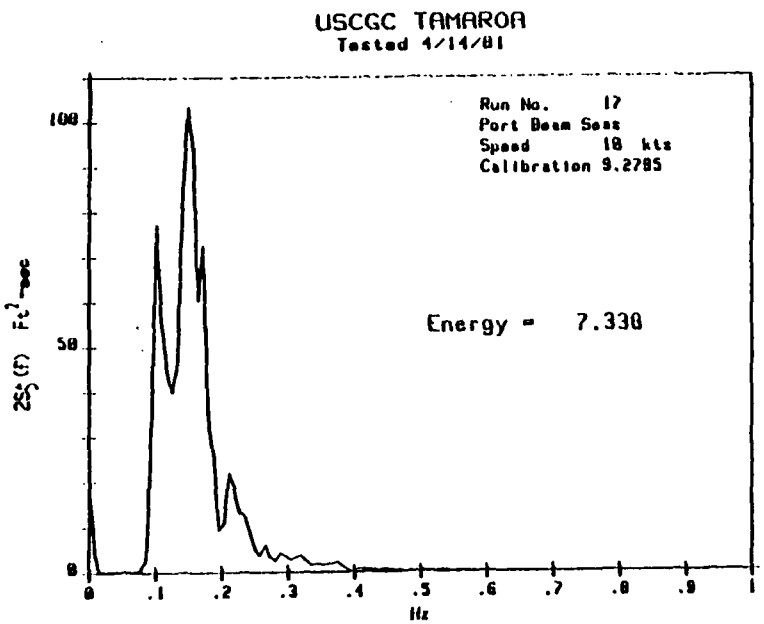


ROLL RESPONSE AMPLITUDE OPERATOR



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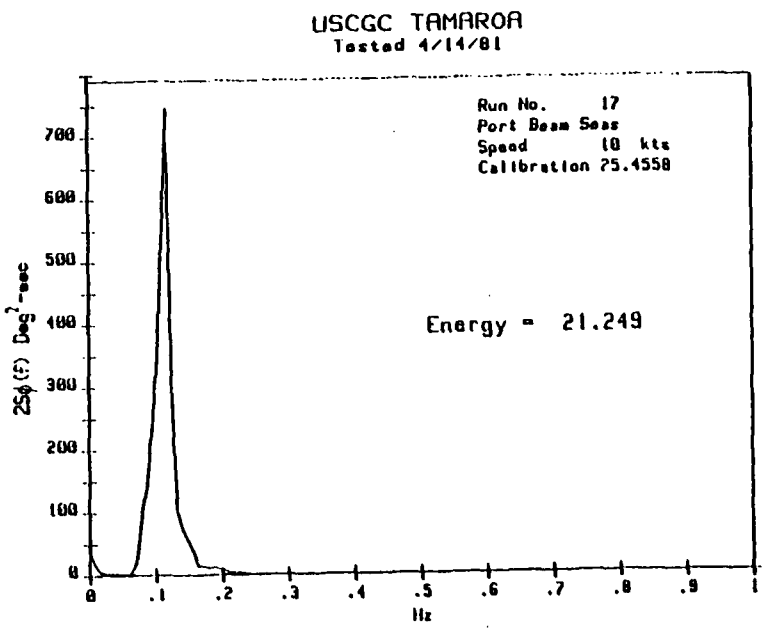

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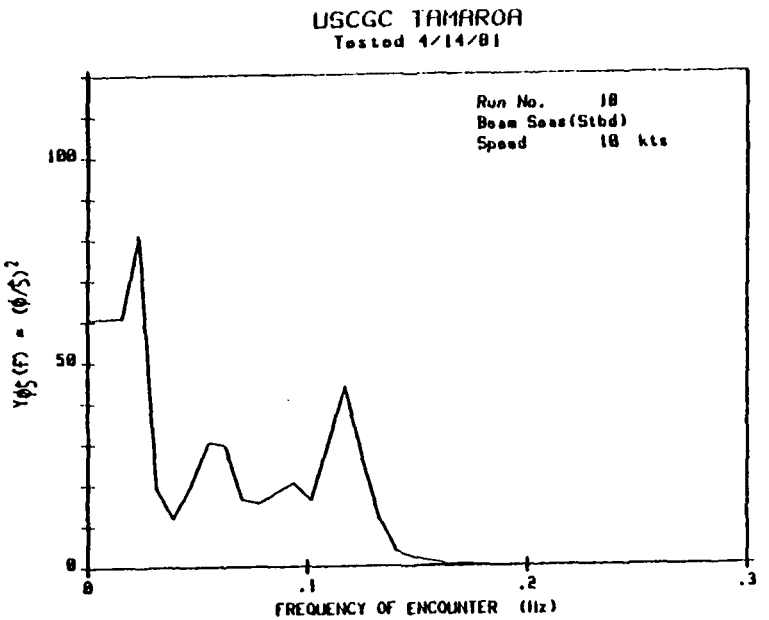
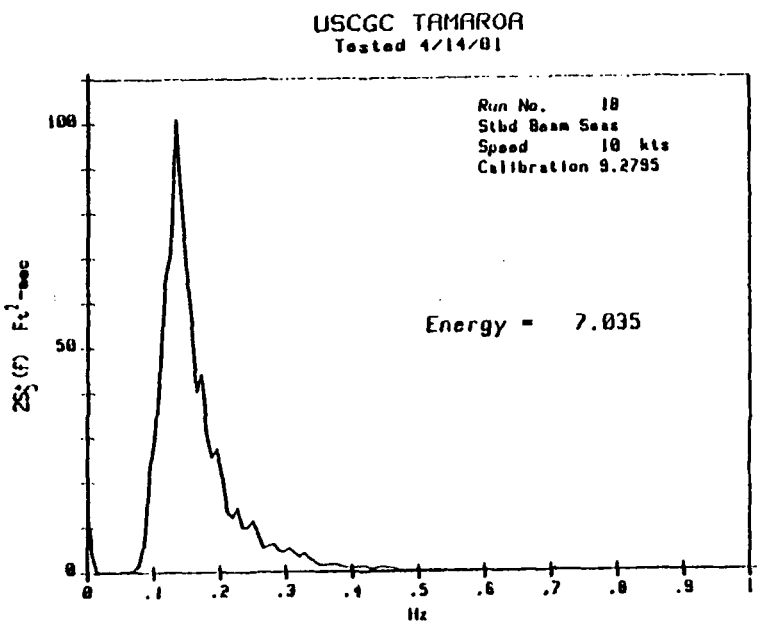
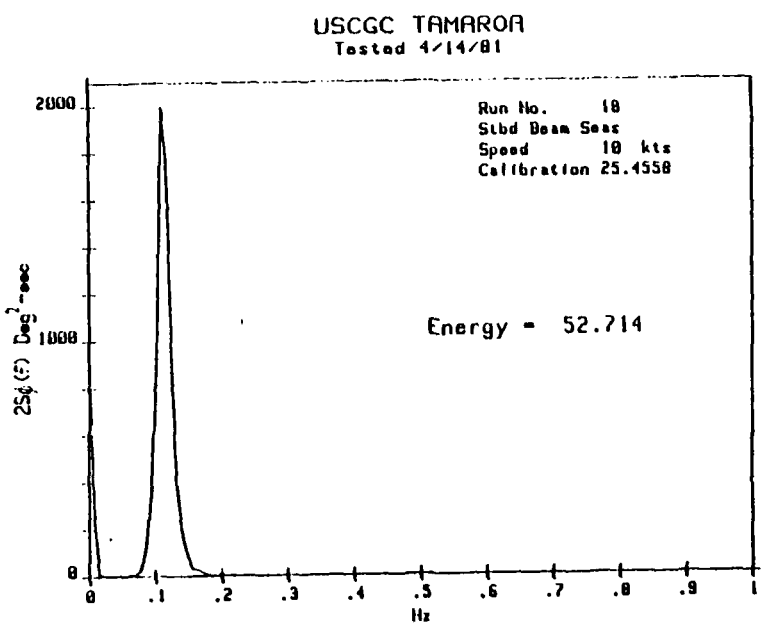


ROLL RESPONSE AMPLITUDE OPERATOR

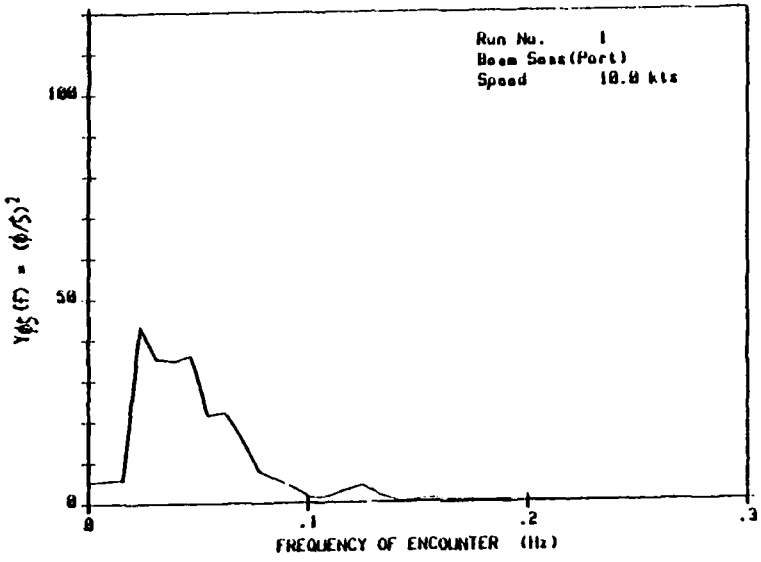


WAVE ENERGY SPECTRUM



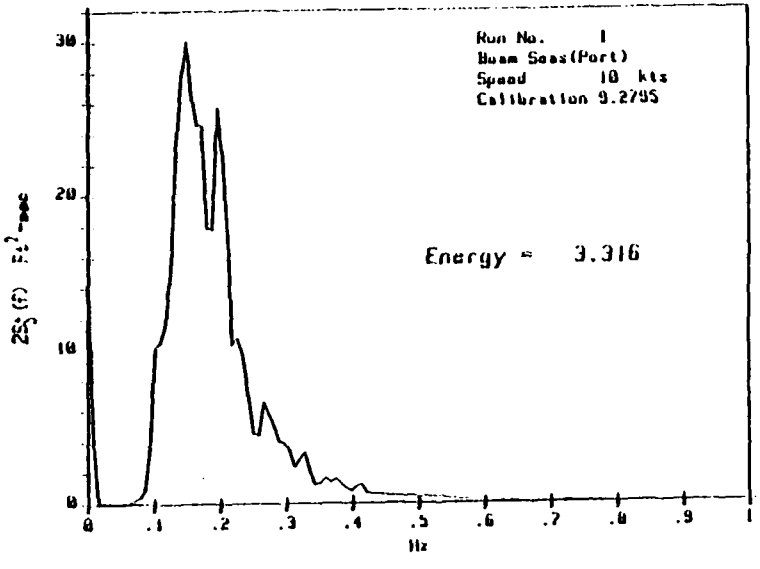
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/01



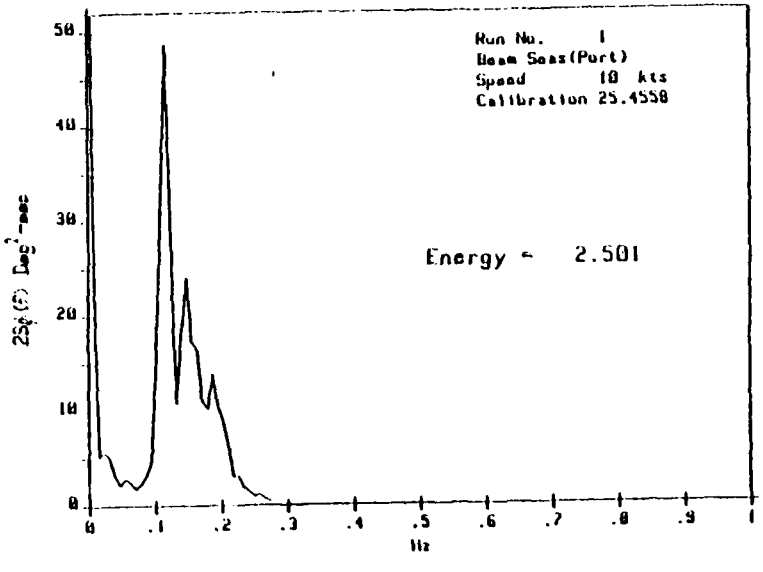
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/01



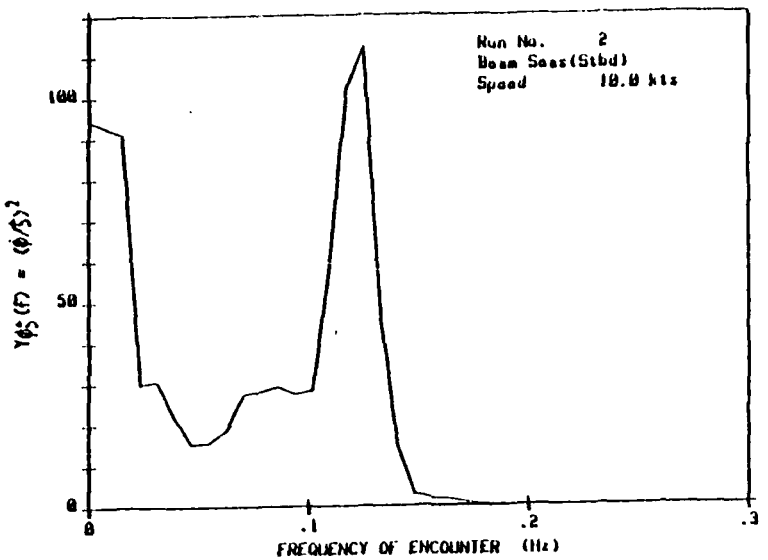
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/01



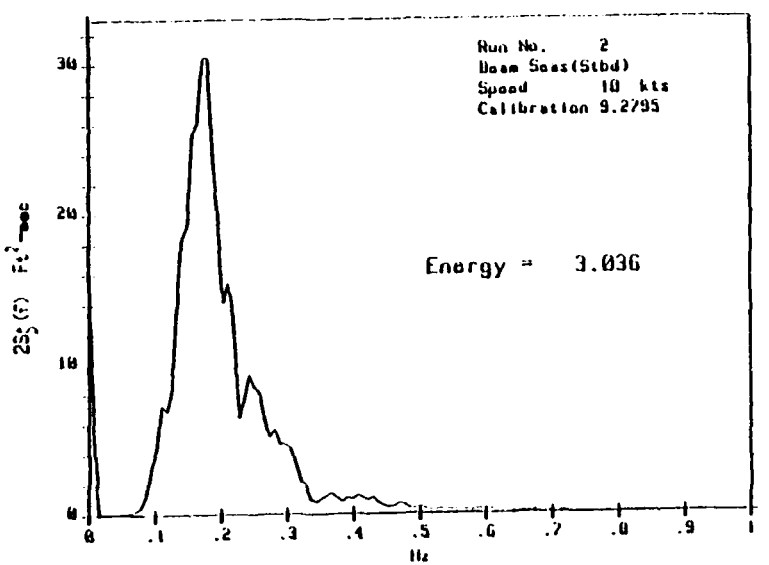
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



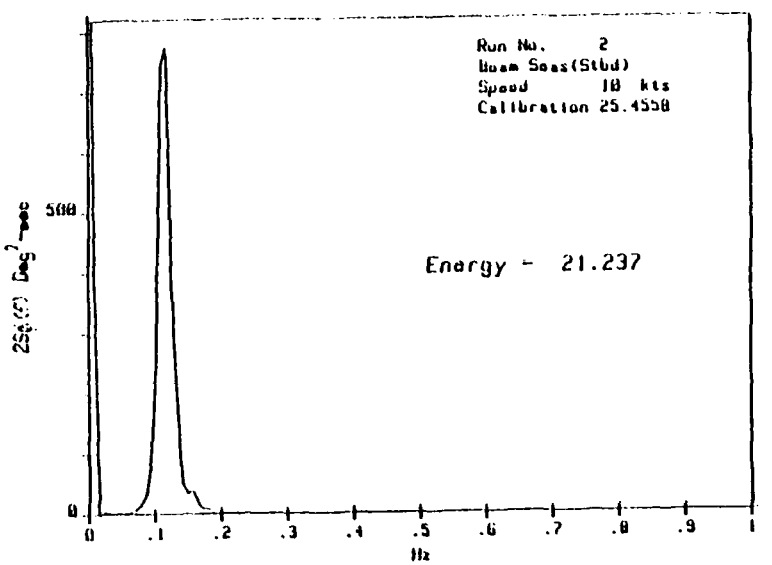
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81

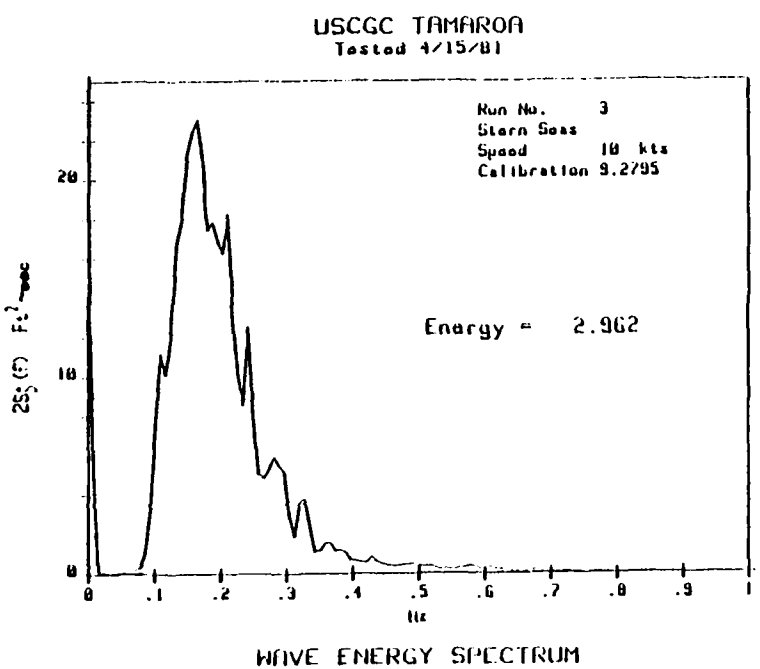


WAVE ENERGY SPECTRUM

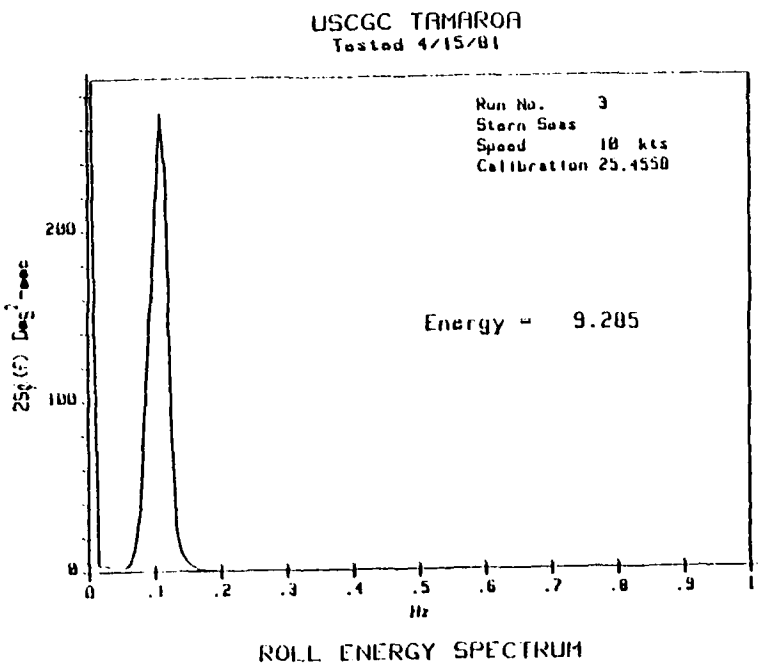
USCGC TAMAROA
Tested 4/15/81



ROLL ENERGY SPECTRUM

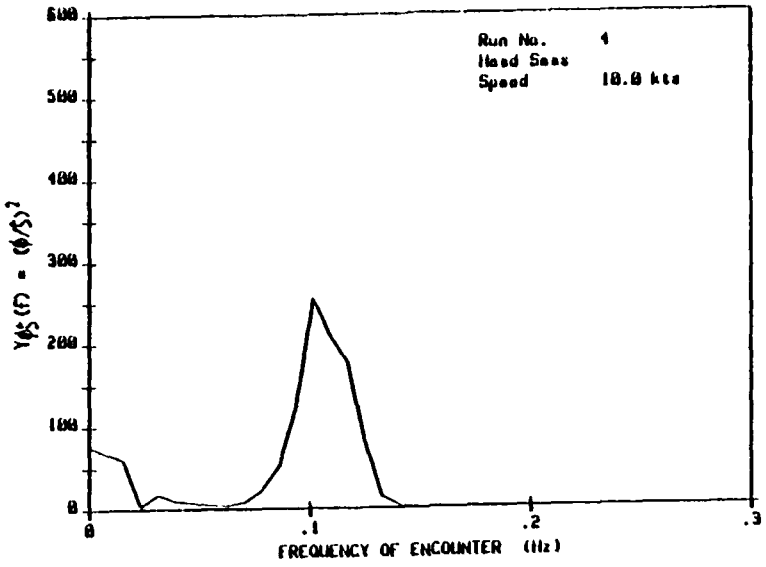


WAVE ENERGY SPECTRUM



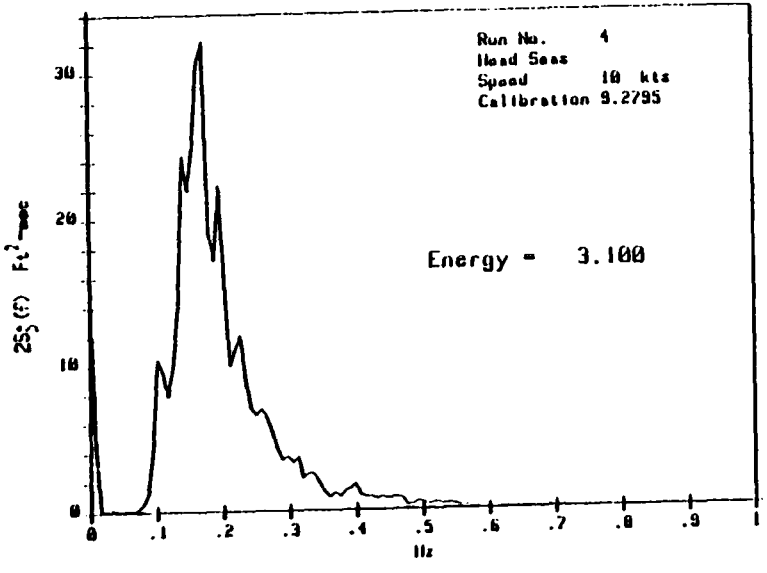
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



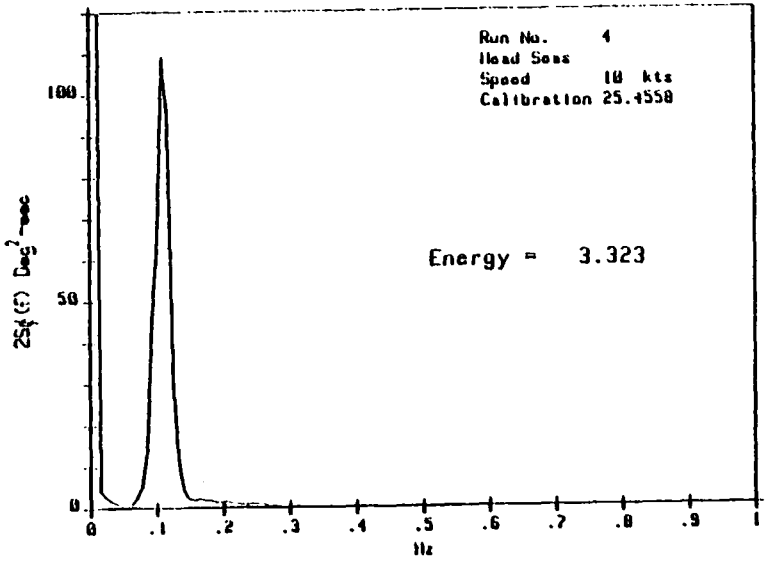
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81

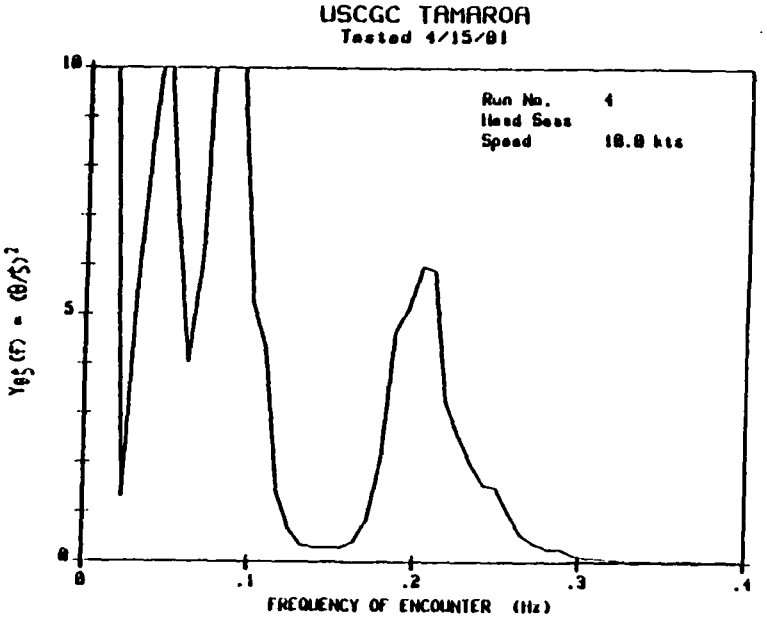


WAVE ENERGY SPECTRUM

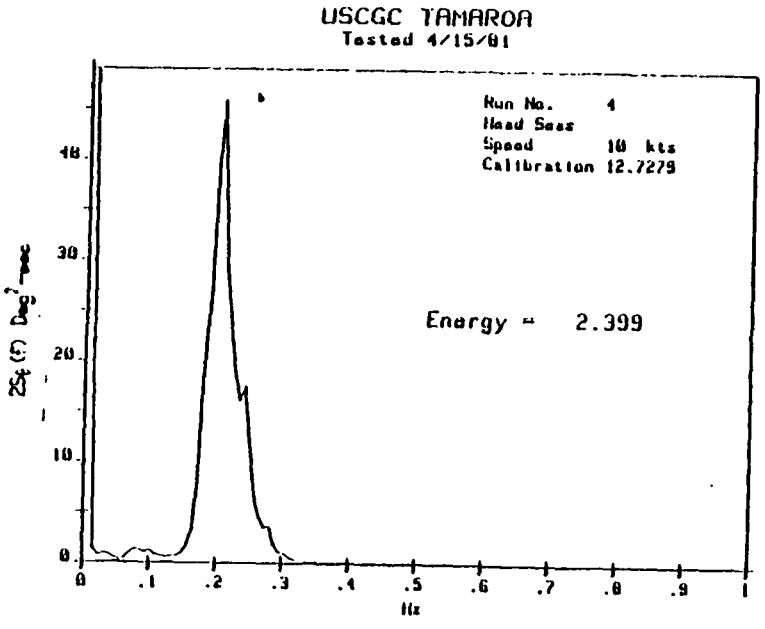
USCGC TAMAROA
Tested 4/15/81



ROLL ENERGY SPECTRUM

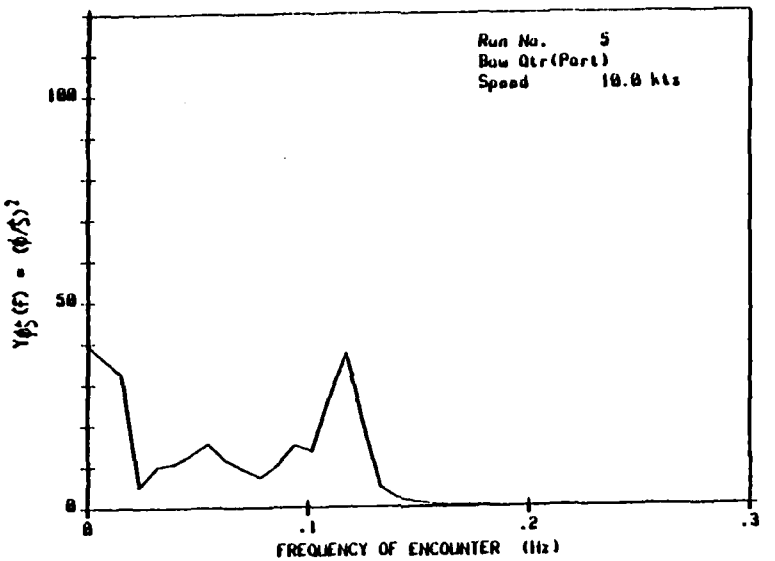


PITCH RESPONSE AMPLITUDE OPERATOR



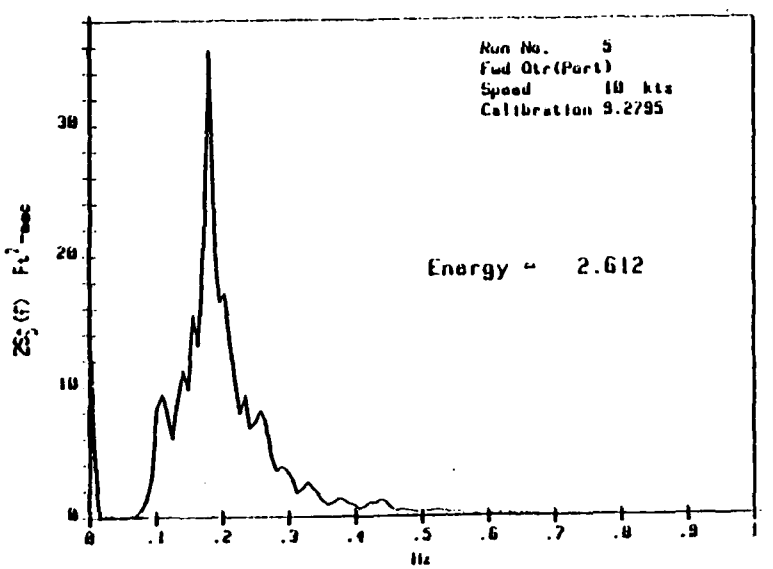
PITCH ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/01



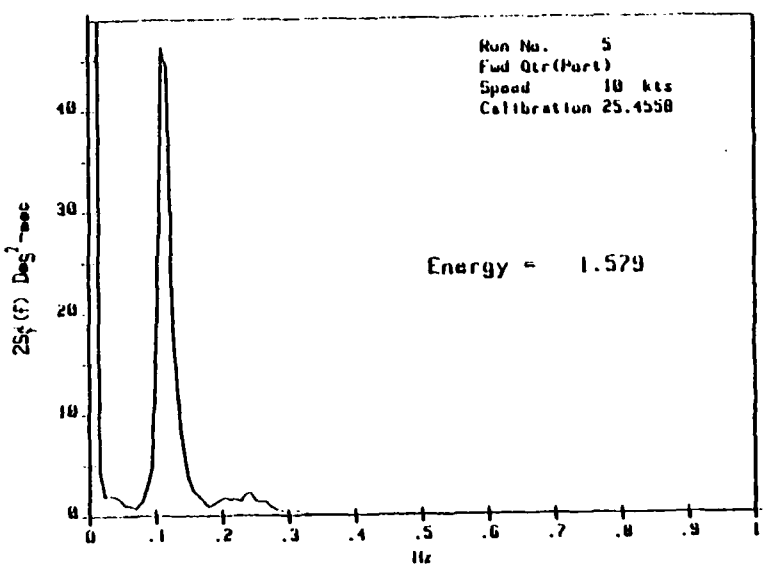
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/01



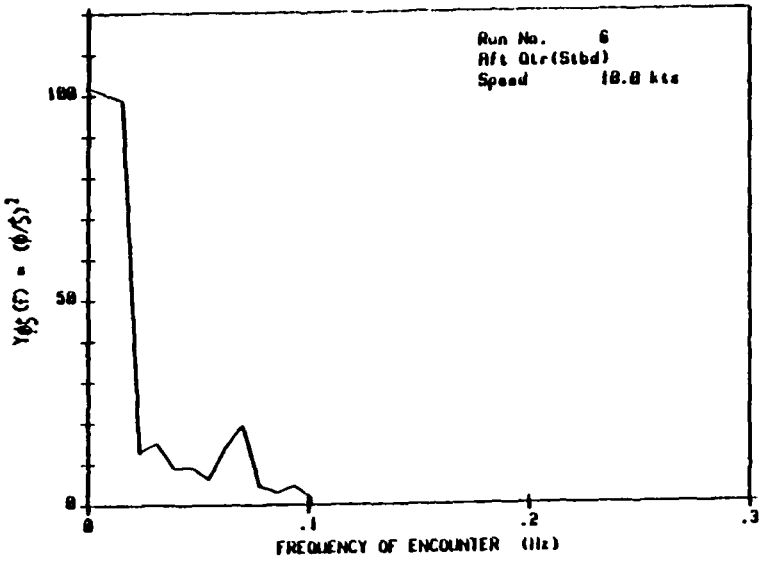
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/01



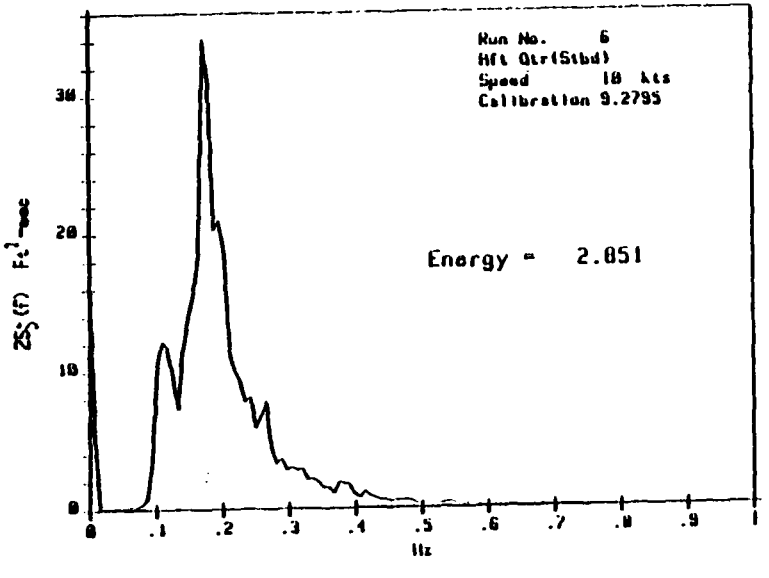
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



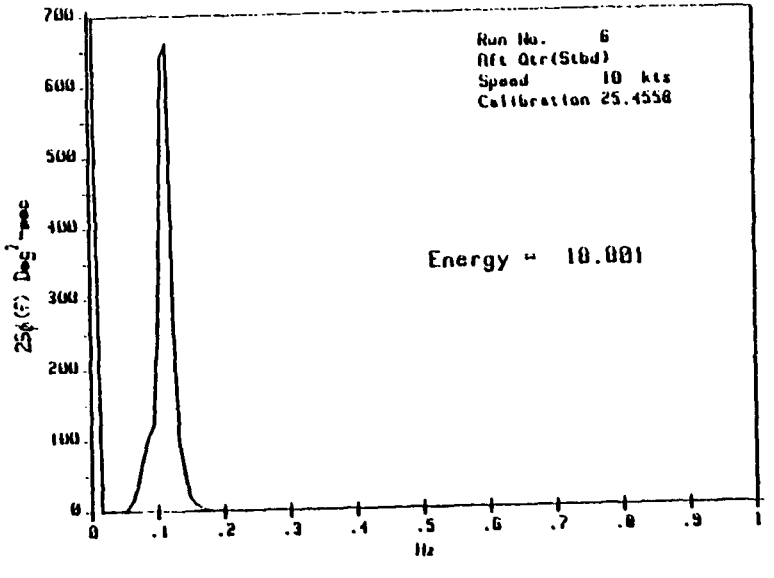
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81



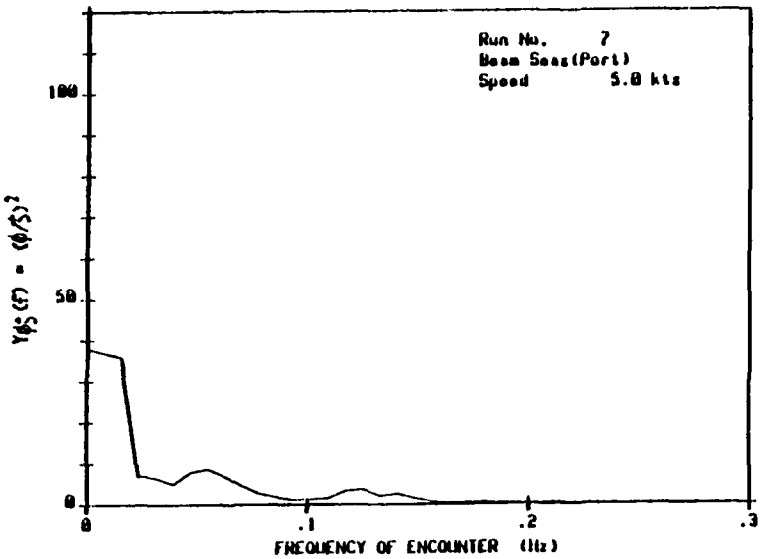
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



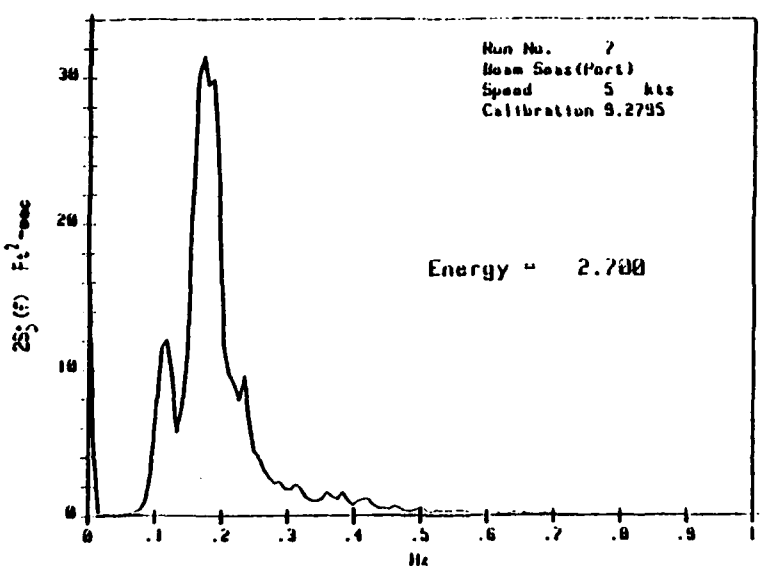
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



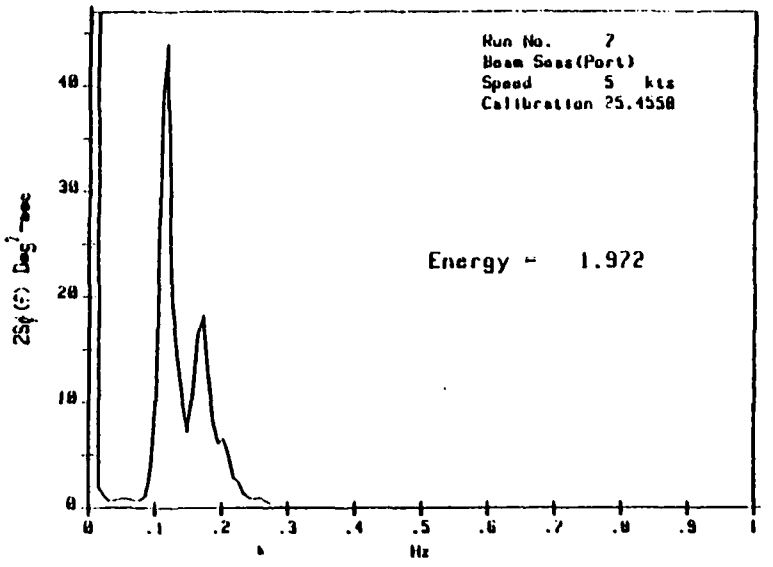
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81



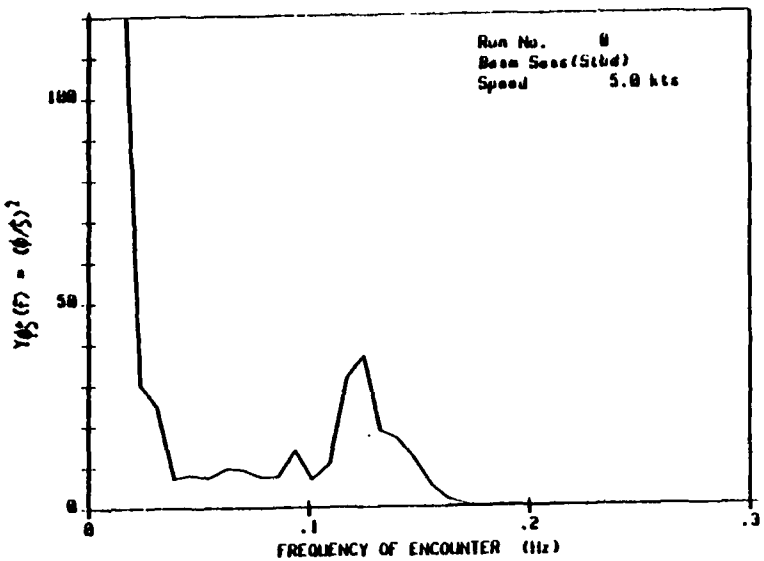
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



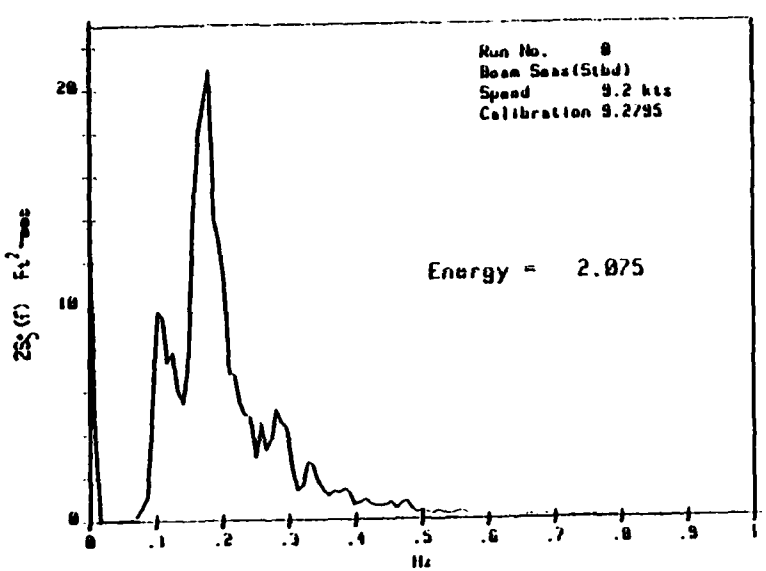
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



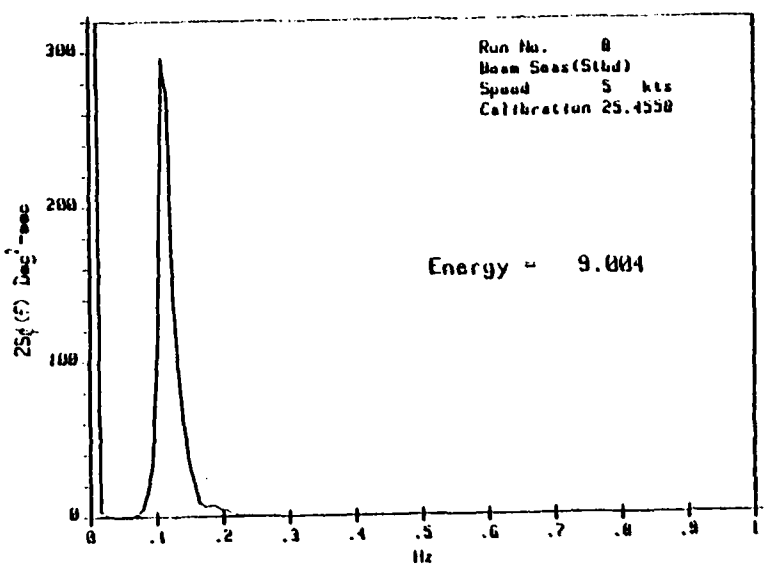
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81



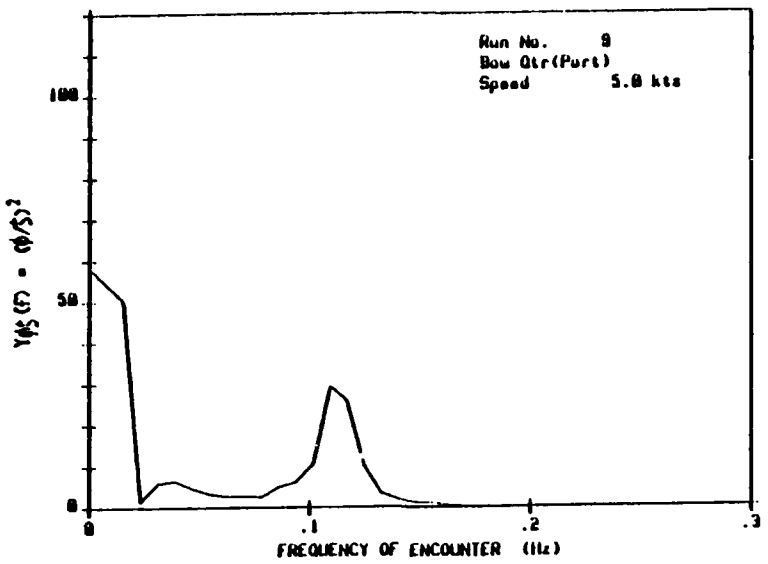
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



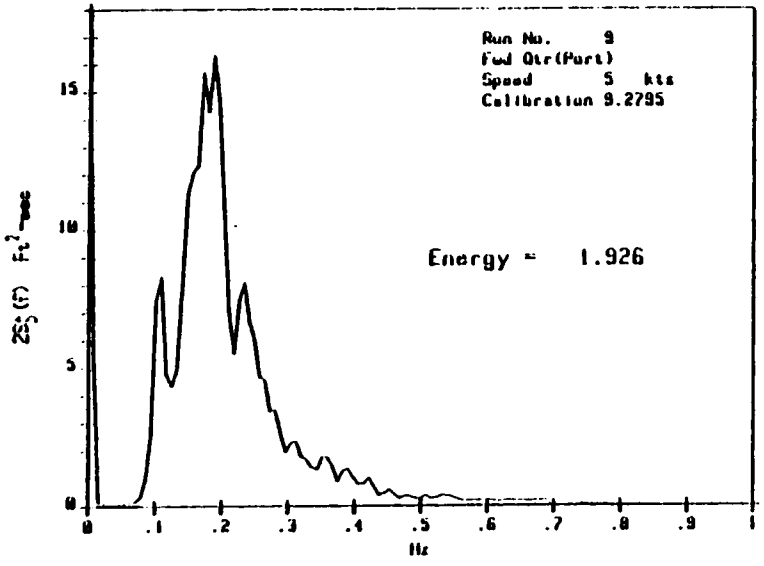
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



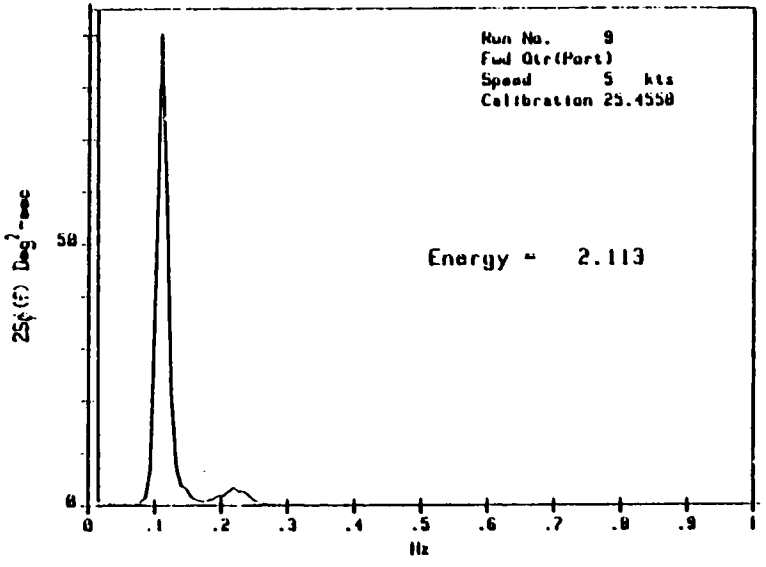
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81



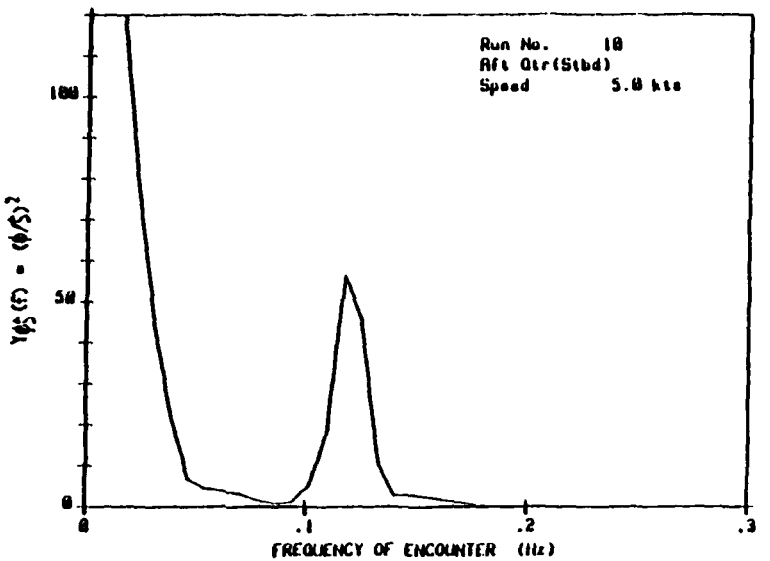
HAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



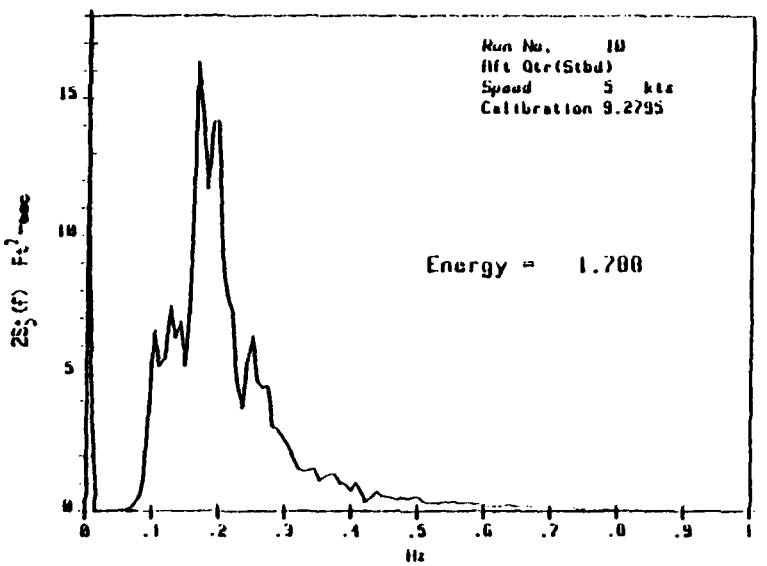
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



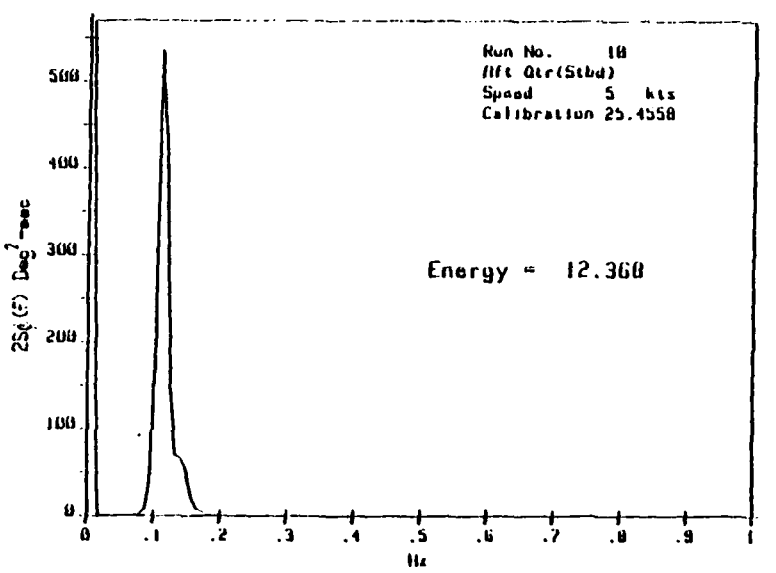
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81



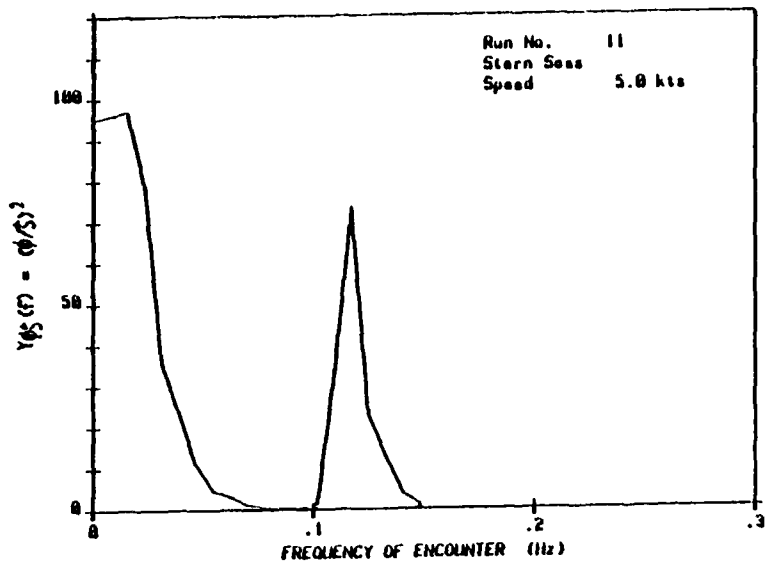
WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



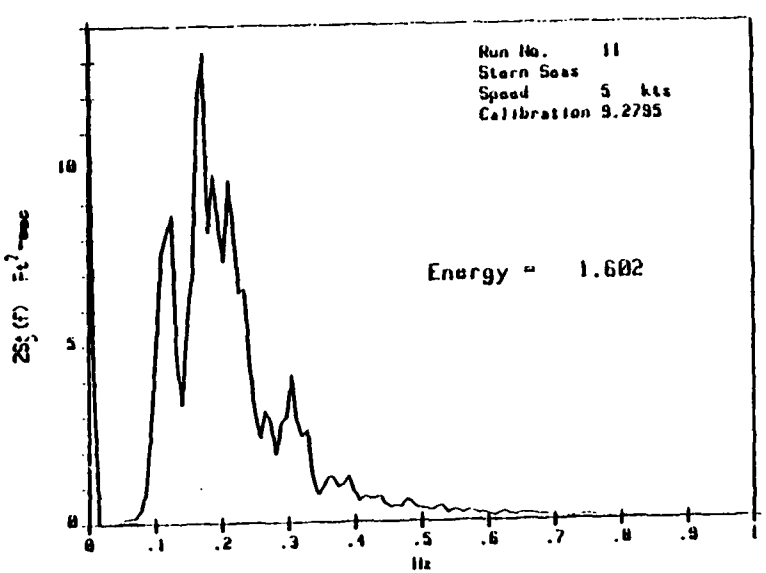
ROLL ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



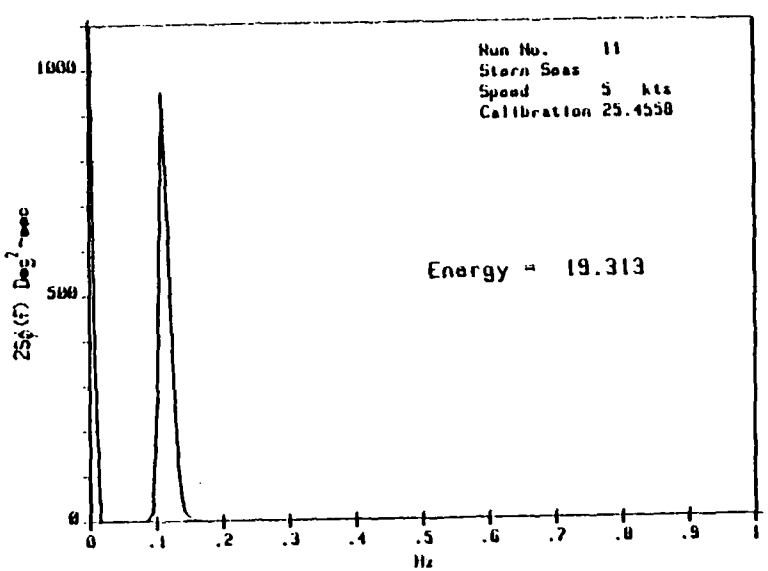
ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81



WAVE ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



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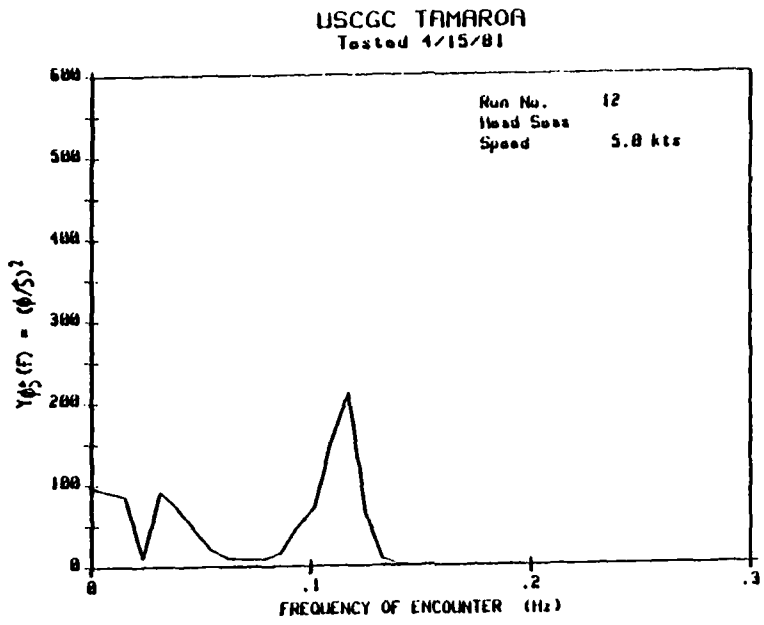

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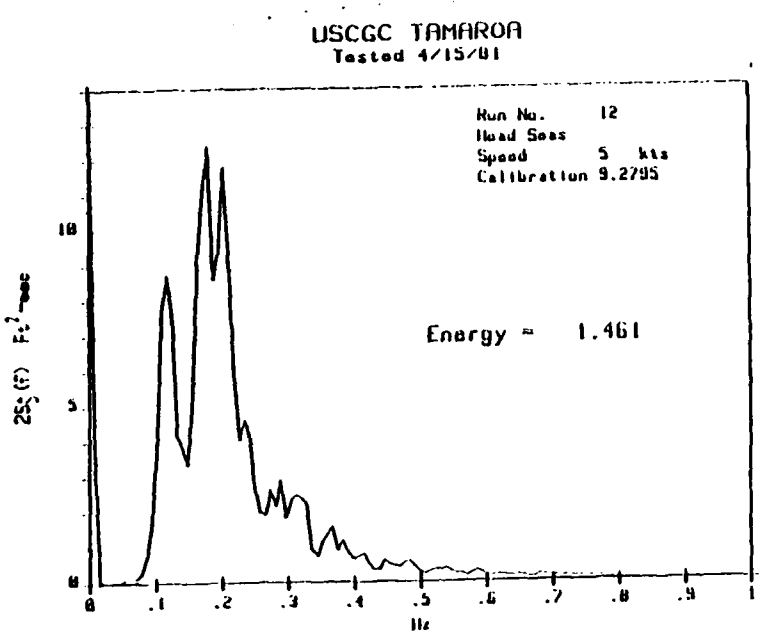

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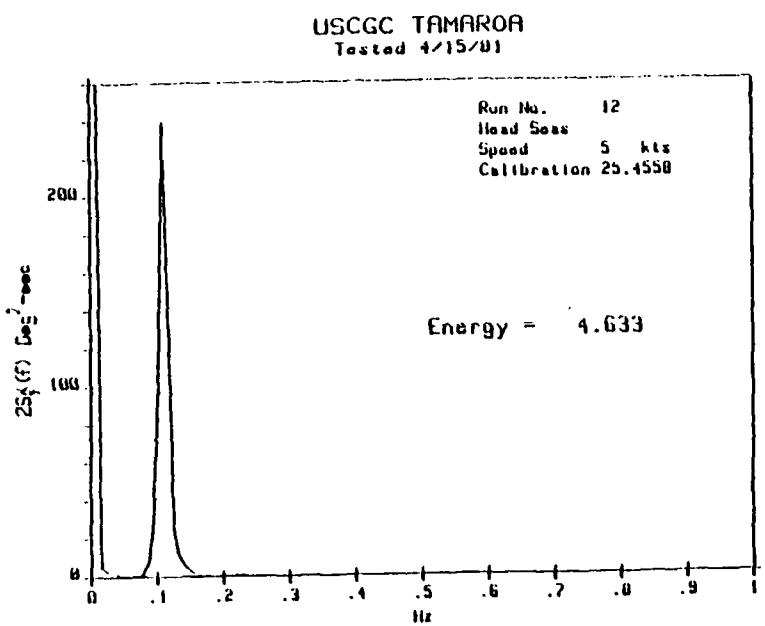

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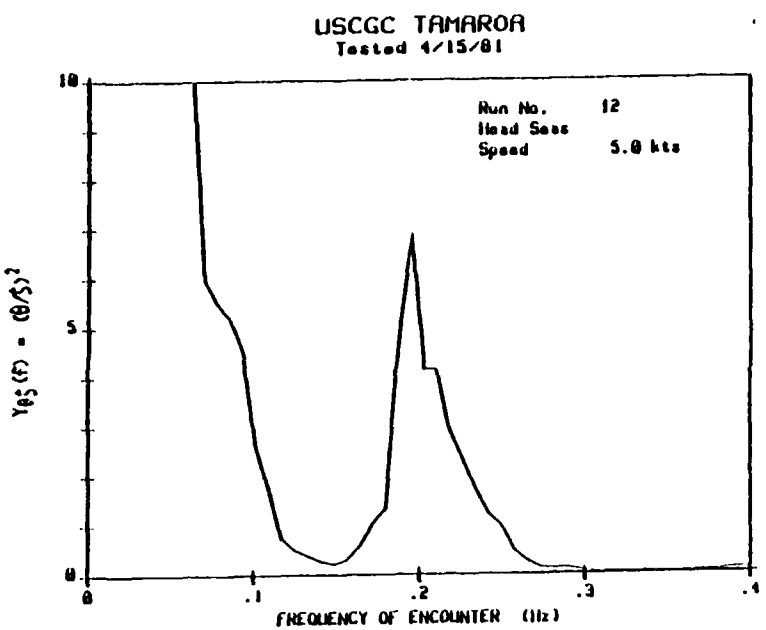
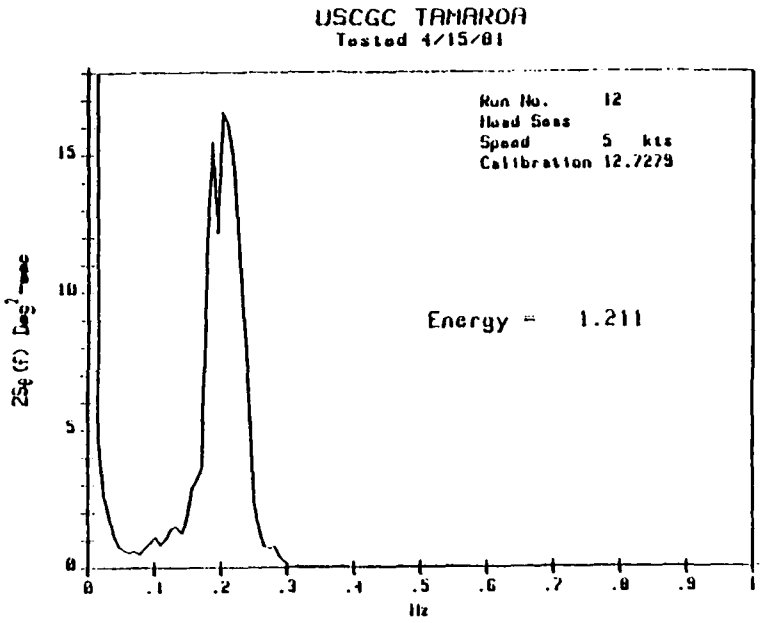


PITCH RESPONSE AMPLITUDE OPERATOR



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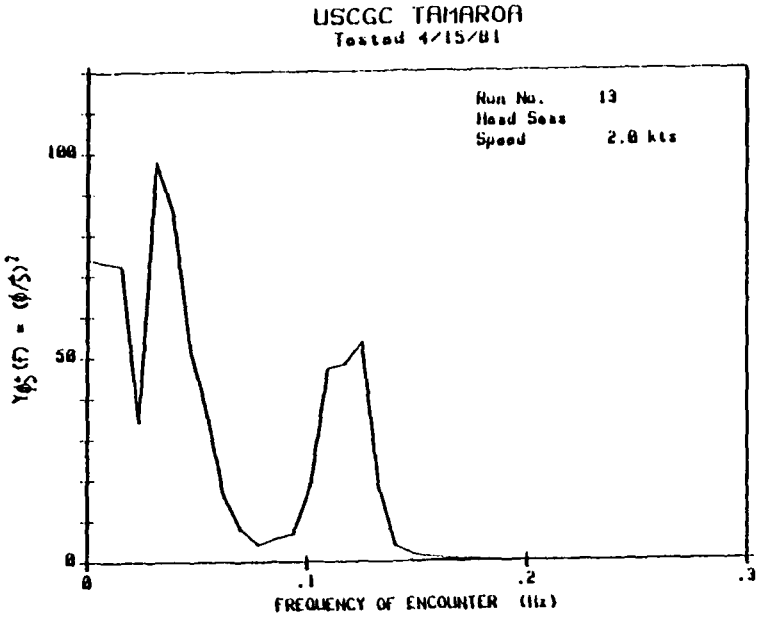

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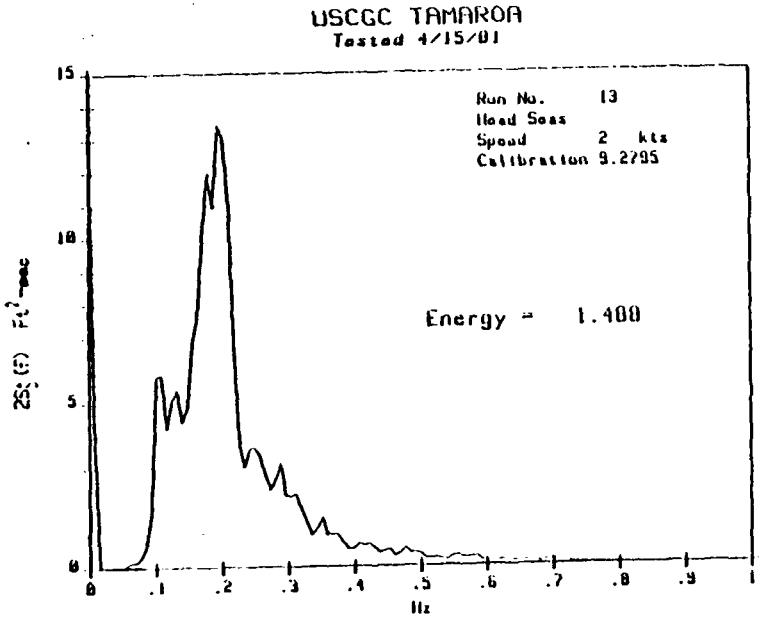

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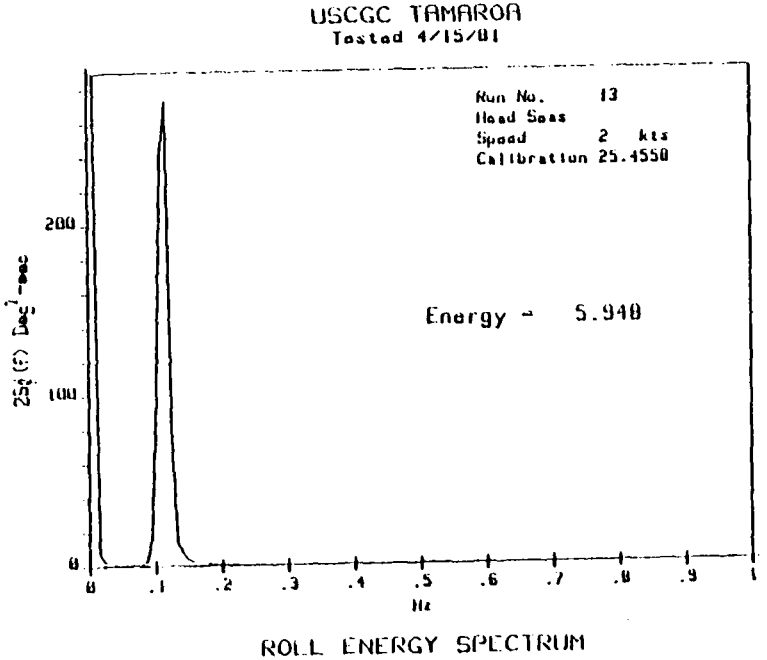

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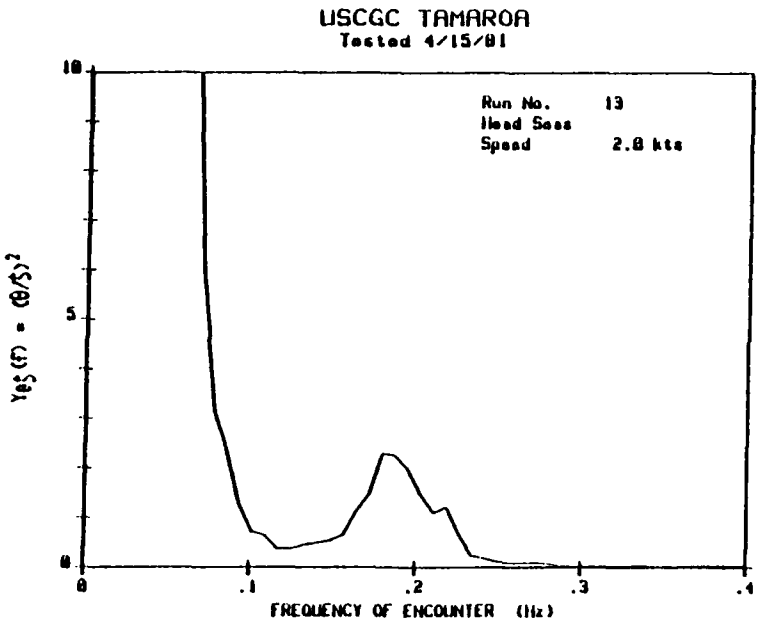

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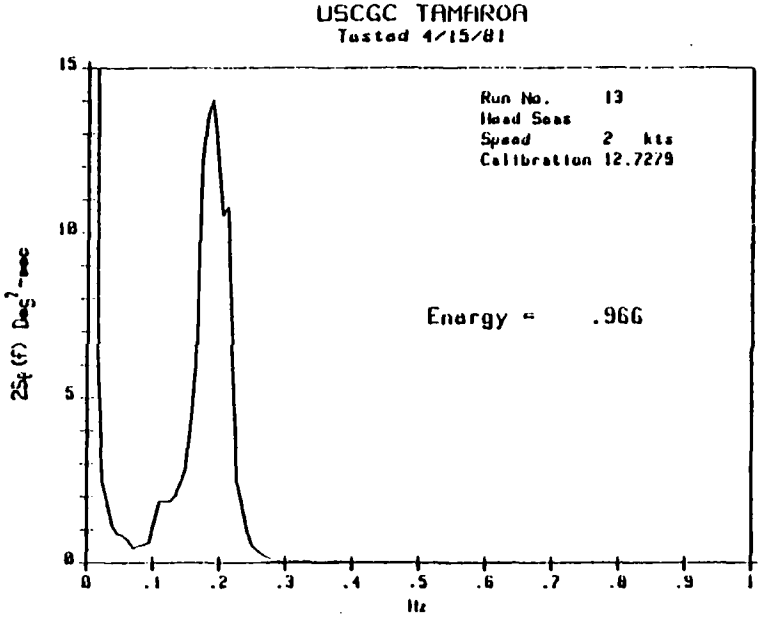
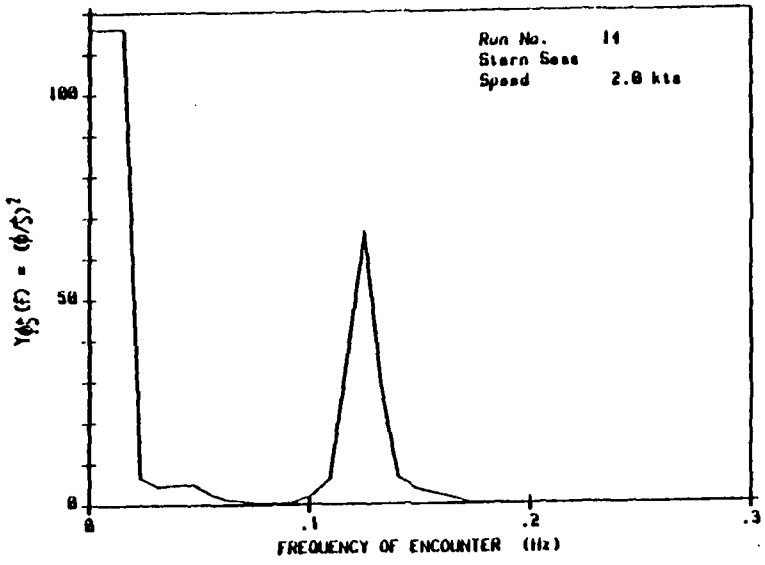


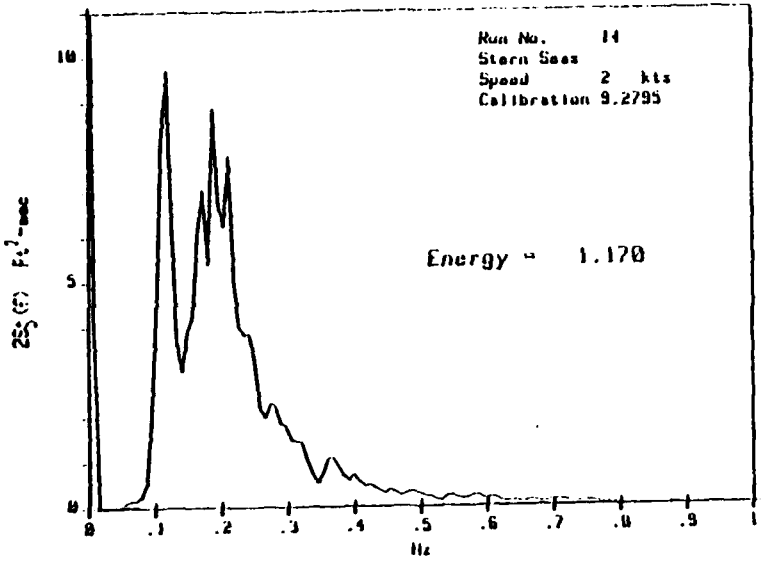
PITCH ENERGY SPECTRUM

USCGC TAMAROA
Tested 4/15/81



ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81



WAVE ENERGY SPECTRUM

USCGC TAMAROA
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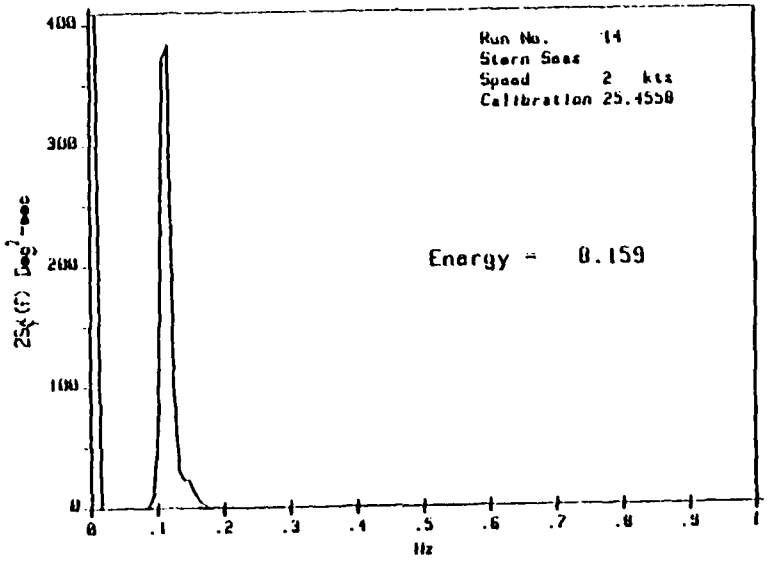

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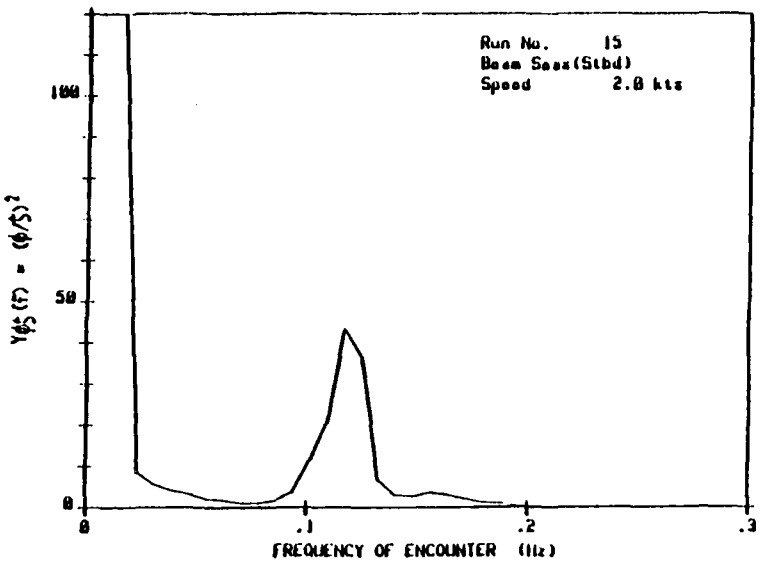

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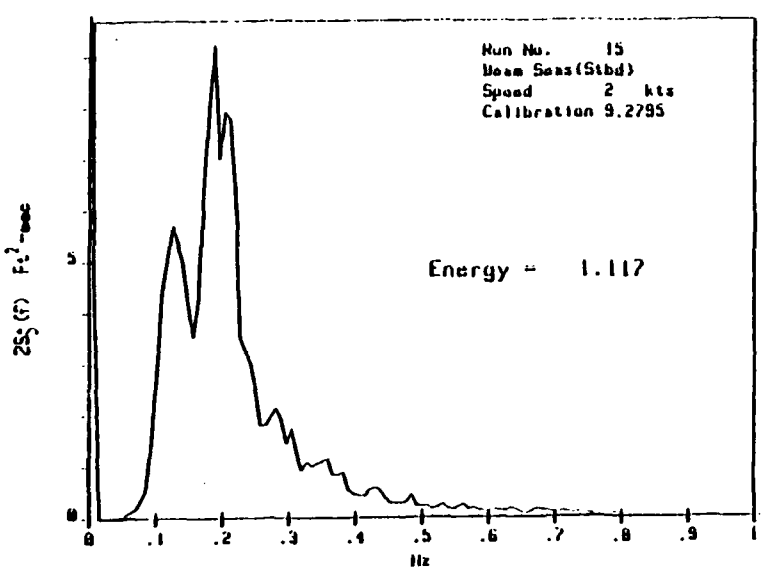
USCGC TAMAROA
Tested 4/15/81



WAVE ENERGY SPECTRUM

USCGC TAMAROA
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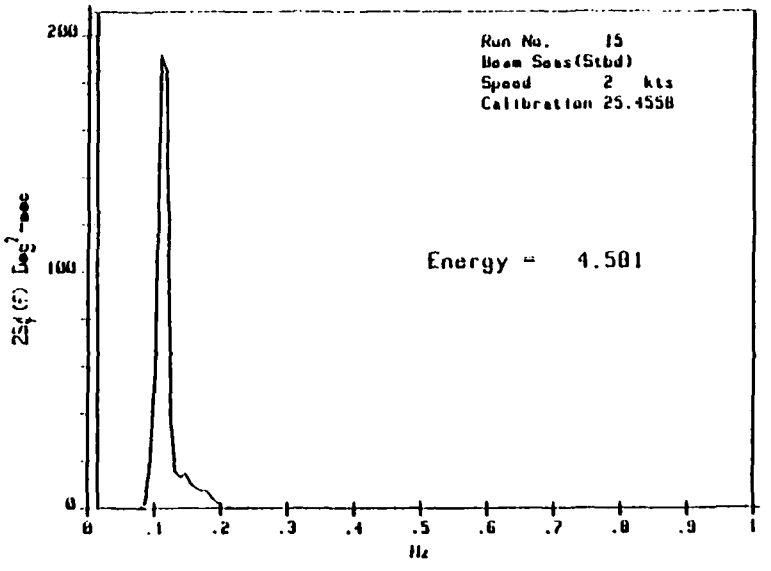

ROLL ENERGY SPECTRUM

USCGC TAMAROA
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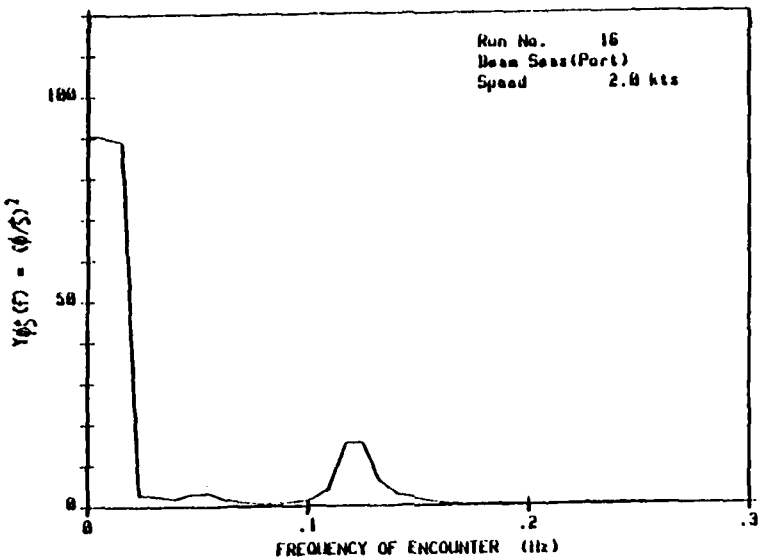

ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
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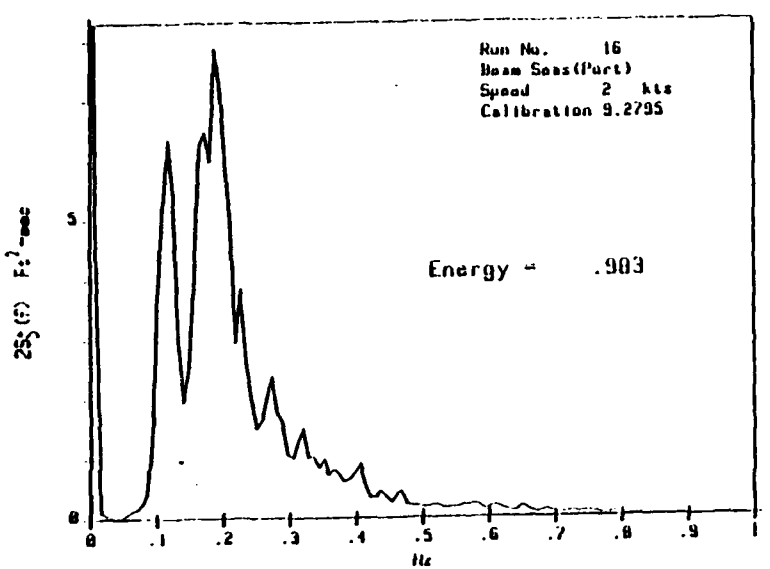

WAVE ENERGY SPECTRUM

USCGC TAMAROA
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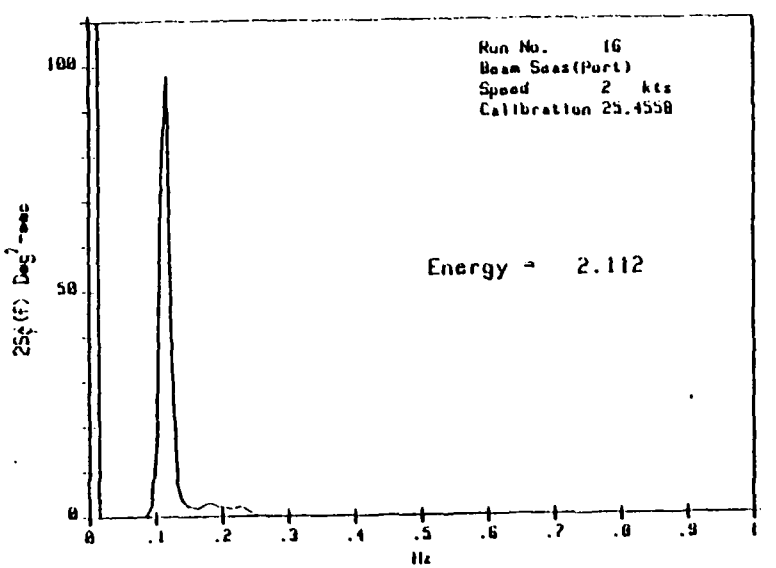

ROLL ENERGY SPECTRUM

USCGC TAMAROA
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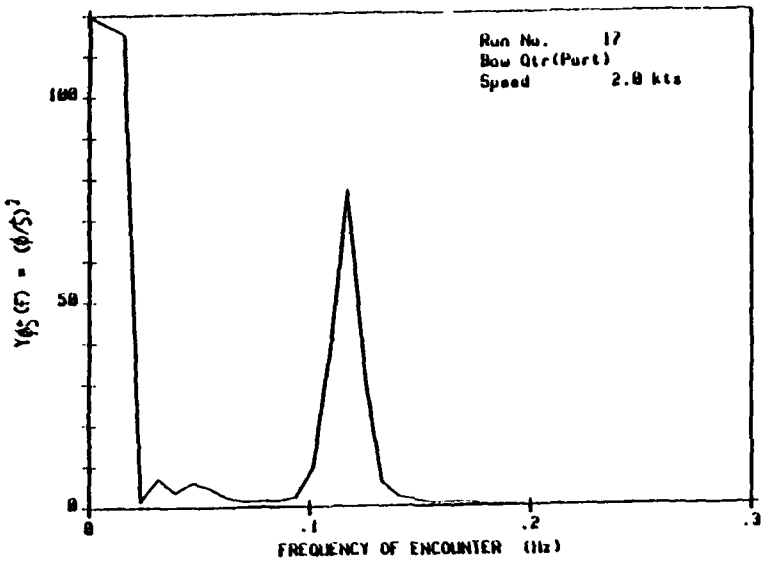

ROLL RESPONSE AMPLITUDE OPERATOR

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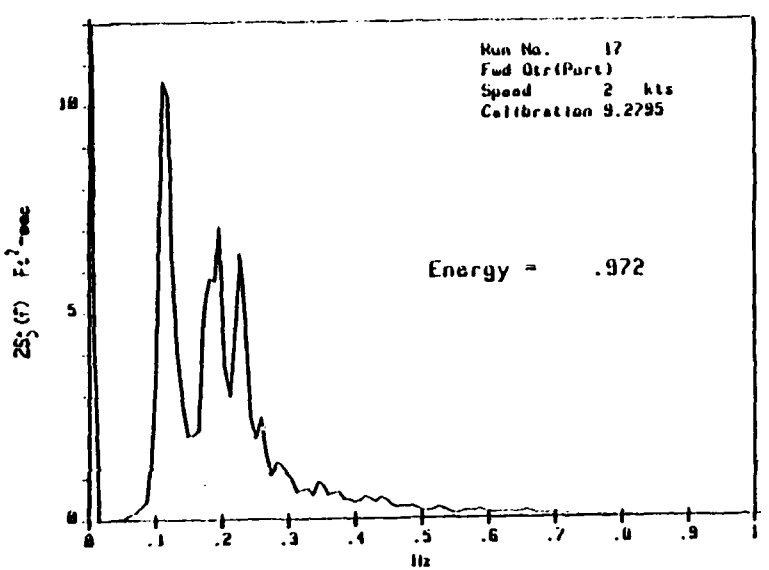

WAVE ENERGY SPECTRUM

USCGC TAMAROA
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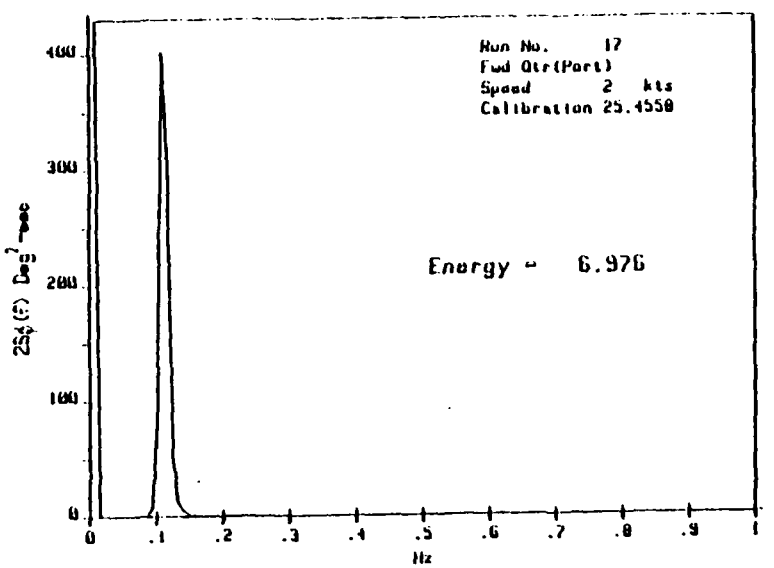

ROLL ENERGY SPECTRUM

USCGC TAMAROA
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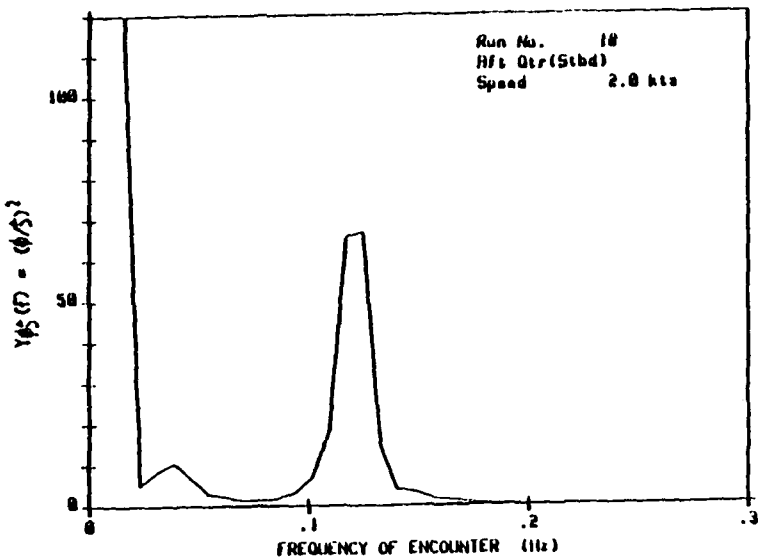
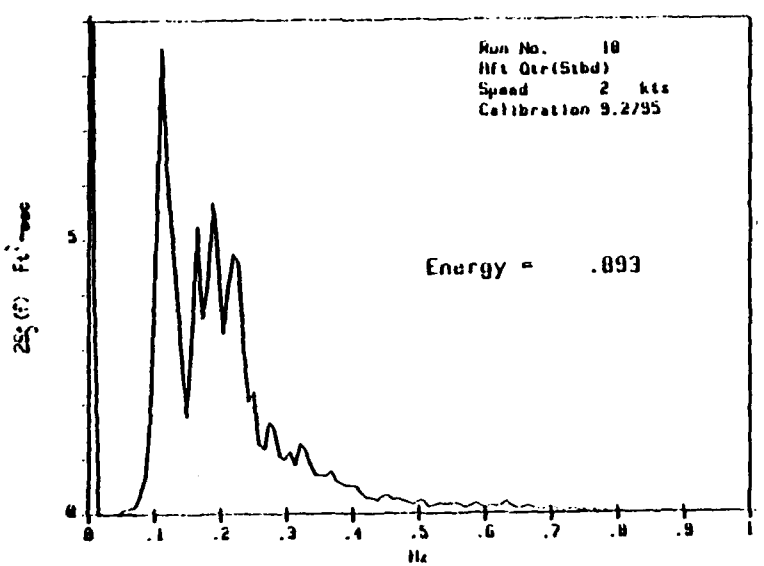


ROLL RESPONSE AMPLITUDE OPERATOR

USCGC TAMAROA
Tested 4/15/81



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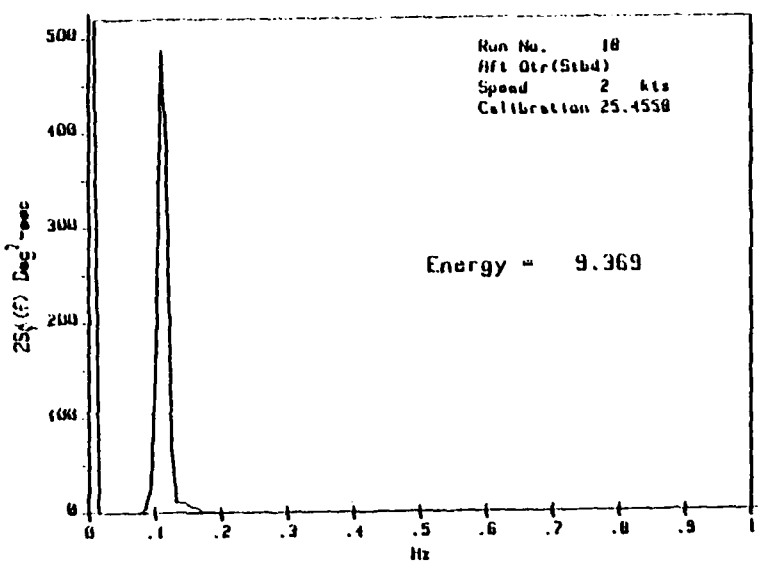

ROLL ENERGY SPECTRUM